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CATHERINE GANSEVOORT LANSIN

granddaughter of
General Peter Gansevoort, junior
and widow of the
Honorable Abraham Lansing
of Albany, New York

CHEMISTRY,

AND

FAMILIAR SCIENCE.

CONTAINING, IN A CONDENSED FORM,

THE ELEMENTARY PRINCIPLES,

AND

ALL THE MOST IMPORTANT FACTS OF THE SCIENCE.

BY J. DAVY.

Intended as a Text-Book for Academies, Schools, &c.

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PREFACE.

Some apology may appear necessary for offering a new elementary work on the science of Chemistry. The writer of these pages made use of them in the form of manuscript for several years, in instructing classes in Chemistry, in which they proved very useful in facilitating this interesting study. They were originally written in the form of lectures, which the author designed merely for the use of his own class; but through the suggestions of several individuals, he has been induced to offer them to the public; after having rewritten them in the form of questions and answers, and simplified them so as to make it useful and interesting for practical elementary instruction. A work of this kind admits but little originality. The materials employed lie open to all. The writer has consulted the works of others, and has derived many principles from some of their invaluable works.

In a few instances the names of authors are introduced in the text, but the source from which extracts

have been taken, and the books which have been consulted are the following: Turner's Chemistry, Beck's Chemistry, Gray's Chemistry, Draper's Chemistry, Arnott's Elements of Physics, Bigelow's Technology, Parker's Philosophy and Brocklesby's Mineralogy.

J. DAVY.

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Order 3. Contains the sulphur-salts, or those which the electro-positive or negative ingredient is a sulphuret.

Order 4. Contains the haloid-salts, or those of which the electro-positive or negative ingredient is haloidal.

The Fourth Part is Organic Chemistry, which treats of those compounds which are of animal or vegetable origin.

CHEMISTRY, ETC.

LECTURE I.

What is Chemistry?

Chemistry is one of the natural sciences.

Are there any of the other sciences intimately connected with Chemistry?

Natural Philosophy and Natural History are intimately connected with Chemistry, and from this fact they have been termed sister sciences.

What is Natural Philosophy?

Natural Philosophy is the science which treats of the motions of the heavenly bodies.

What is its office?

To trace the planets in their course (in the far distant regions of space), and to observe the laws and operations of motion and forces.

Into how many branches may Natural History be divided?

Natural History may be divided into three branches: 1st. Zoology, which treats of animals; 2d. Botany, which treats of the classification, appearances, habits and properties of vegetables; 3d. Mineralogy, which

treats of stones, earth, &c. Geology, which treats of minerals as they exist in masses forming rocks, is a branch of Mineralogy.

What is that science called, which is now about to engage our attention?

Chemistry is that science, and by it we are enabled to examine the relations which affinity establishes between bodies.

What does Chemistry teach?

Chemistry teaches us to investigate the elements of all material things; to study the compound nature of substances; to classify, arrange, and, by various combinations, to beautify the world of matter.

Does chemistry bear an important relation to the useful arts?

Chemistry bears an important relation to the useful arts: many of the inventions of modern days owe their origin to this science.

To what persons is a knowledge of chemistry of great use?

A knowledge of chemistry is of great use to all persons who are engaged in the business of life. The glass-maker exhibits chemical phenomena in combining alkaline, saline, metallic and earthy materials. The tanner, by a chemical process, converts the skins of animals into the various kinds of leather, which is found so very useful in the manufacturing of shoes, &c.

Is it of use to any other persons?

It is of great use to the agriculturist and the physician.

Of what particular benefit is it to the agriculturist?

A knowledge of chemistry enables the agriculturist to examine the composition of the various strata of which the soil is composed, and instructs him how to enrich it so as to be susceptible of cultivation.

Has the physician received much assistance from chemistry?

The physician has derived great assistance from the study of chemistry.

Do they now consider it important to those who are engaged in the study of medicine?

It is considered as indispensable in the medical profession.

What has it enabled the physician to do?

It has enabled the physician to analyze the various elements necessary to form a compound. He finds several simples, when united, efficacious in the relief of a particular disease; and, by the aid of this science, he can determine what proportions will unite with substances without decomposing them.

How do chemists divide substances?

Chemists divide substances into simple and compound.

What is a simple substance?

A simple substance is one which has never been decomposed.

What is a compound substance?

A compound body is one which is composed of two or more simple bodies.

How is the composition of bodies ascertained?

The composition of bodies is ascertained by two methods.

What are they called?

Analysis and synthesis.

What is meant by analysis?

By analysis, we mean the separating of a substance into its elementary parts.

What is meant by synthesis?

By synthesis, we mean the reunion of the parts to form a compound.

How many of the elementary substances are there?

The elementary substances entering into combination with each other to form all material things, are fifty-six in number.

With how many are we intimately acquainted?

We are intimately acquainted with eighteen—the remainder are rare.

On what is the science of chemistry based?

The science of chemistry is based upon experiment.

What has it therefore been called?

The name Experimental Philosophy has been applied to it.

How many methods of experimenting are there?

There are three methods of experimenting.

What are brought to light by experiment?

New facts are brought to light by experiment.

What are the three methods of experimenting?

The three methods of experimenting are determinative, demonstrative and productive.

What is determinative?

Determinative is the process of telling what a body is.

What is demonstrative?

Demonstrative is the process of proving by experiment.

What is productive?

Productive is the uniting of elements to form a body.

What is the process by which we arrive at a knowledge of chemistry?

The process by which we arrive at a knowledge of chemistry is, solution, fusion, ignition, evaporation and crystallization.

Is chemistry a useful and important study?

Chemistry is a very useful and interesting study, as it unfolds the laws, and enables us to discover in many instances the secret operations of nature.

Does the study of the sciences tend to elevate the human mind?

The question has often been asked, "Does the study of the sciences tend to establish the mind in the truths of religion, and promote Christian humility; or rather, does not science put nature in the place of God, and heighten the pride of man, by filling him with lofty notions of his own powers, which can thus penetrate the mysteries of creation?" It is true that such effects may arise from a superficial study of the sciences; but when we become so deeply engaged in philosophical investigations, as to forget Him whose works we study, we are wandering from the path of true knowledge.

PART I.

IMPONDERABLE SUBSTANCES.

LECTURE II.

GENERAL REMARKS ON THE IMPONDERABLES.

By what names are certain agents called, of which the nature is unknown, although they have a very important influence over matter?

They are called imponderable agents.

Why are they called imponderable agents?

They are called imponderable agents, because they have no appreciable weight.

What may they be considered?

They may be considered as invisible fluids pervading all nature.

By what names are the imponderable agents called?

The imponderable agents are caloric, light, electricity, magnetism, and galvanism.

What is caloric?

Caloric is an invisible agent which pervades all bodies, and causes an expansion or separation of the atoms.

What is light?

Light is that principle or medium by which objects are made perceptible, and through which we are enabled to exercise the sense of vision.

What is magnetism?

It is the name given to the unknown principle in some kinds of iron, which endows them with a power of attracting other pieces of iron.

Where are its effects seen?

In the adhering of iron to a magnet: if a magnet is held near iron, it will approach it.

What is electricity?

Electricity is an invisible subtle fluid, that appears to pervade all nature.

LECTURE III.

CALORIC.

What is caloric?

Caloric is the agency which produces the sensation of heat.

Then what do you mean by caloric?

Heat, which is the effect of the passage of caloric from one body to another.

Then is caloric a ponderable or imponderable substance?

Caloric is an imponderable substance.

How is it proved that caloric is imponderable?

It is proved that heat or caloric is imponderable, by its being so very light, that there is no appreciable difference in the weight of a body, whether it is hot or cold.

In what state does caloric exist?

Caloric exists in a free or sensible state, and in a latent or insensible.

What is meant by sensible caloric?

Sensible caloric is that which is capable of producing the sensation of heat.

What is the meaning of latent?

Concealed or hidden.

What is meant by insensible caloric?

Insensible caloric produces no sensation, but exists in a state of apparent combination with bodies.

What is the most important property of free caloric?

Its tendency to an equilibrium.

In how many ways is caloric conducted?

Caloric is conducted in two ways.

What are they called?

Conduction and radiation.

What is meant by conduction?

By conduction, is meant the passage of caloric through a body, particle to particle.

Give an example.

Place pieces of phosphorus along an iron rod, and apply heat to one end of it; the progress of the caloric will be indicated by its igniting the phosphorus.

Do different substances conduct caloric with different degrees of rapidity?

Different substances conduct caloric with different degrees of rapidity.

Give an example to illustrate this fact?

Take a tin plate and place upon it different substances, such as copper, zinc, china, marble and paper; lay upon each substance a small piece of phosphorus, and place beneath the tin plate a lighted lamp filled *with alcohol.*

From what do the different degrees of rapidity, with which substances conduct caloric, arise?

The different degrees of rapidity with which substances conduct caloric, arise from their different densities.

Which conduct with the greatest rapidity?

Those conduct with the greatest rapidity which are most dense, such as metals.

Which conduct with the least rapidity?

Those which are least dense, such as fur and down.

Do liquids conduct caloric?

Liquids do conduct caloric.

In what way do liquids conduct caloric?

Liquids conduct caloric by an interchange of position among the particles.

Do liquids conduct caloric directly from particle to particle?

Liquids conduct caloric directly from particle to particle, in a feeble degree.

Give an example.

A vessel of water containing particles of amber, with a light placed beneath the vessel; where the water becomes heated, the particles of amber will rise, and the cold particles descend.

Can heat be produced by friction?

Heat can be produced by friction.

Give an example.

The savages light their fires by rubbing together two pieces of wood.

Is the earth a good conductor of heat?

The earth is not a good conductor of heat.

What kind of a conductor is brass?

Brass is a good conductor.

Why are coffee pots made with wooden or ivory handles?

Because if metal were used, it would conduct the heat so readily, that the hand could not bear to touch them.

To receive conducted heat, must we be in contact with it?

To receive conducted heat, we must be in contact with the substance which imparts it.

Can we remain in contact with the fire itself?

We can not.

From whence do we derive our conducted heat?

From the air, a fluid which constantly touches our person.

Which is the most agreeable, radiant or conducted?

Radiant is the most agreeable.

LECTURE IV.

RADIANT CALORIC.

What do you mean by radiant caloric?

The caloric which flows from a heated body is called radiant caloric, because it is thrown off in all directions, like the rays of light from a radiant point.

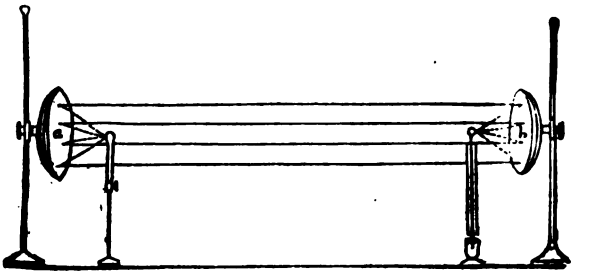
Can radiant caloric be reflected from smooth surfaces.

Radiant caloric can be reflected from smooth surfaces, though polished surfaces do not radiate so rapidly as those which are rough.

Give an example.

Place two concave mirrors at opposite

Fig. 1.



A and B, concave mirrors, fixed on stands. C, heated bullet, placed in the focus of the mirror A. D, thermometer, with its bulb placed in the focus of the mirror B. The dotted lines show the course of the rays of heat diverging from the heated ball C, then rendered parallel by the mirror A, whence they are reflected to the mirror B, from which they converge, and fall upon the thermometer in its focus D.

sides of the table. If we then put a red hot cannon ball in the focus of one of the mirrors, it will instantly affect a thermometer in the focus of the other.

When radiant caloric falls upon rough, dark-colored or opaque bodies, what becomes of it?

When radiant caloric falls upon rough, dark-colored or opaque bodies, the caloric becomes absorbed.

Through what kind of bodies is caloric transmitted?

Caloric is transmitted through transparent bodies.

How many theories have been formed in regard to the radiation of caloric?

There have been two theories formed in regard to the radiation of caloric.

Who were their authors?

Pictet and Prevost.

What is the theory of Professor Pictet, of Geneva?

Pictet supposes that a hot body will radiate caloric to surrounding colder bodies, until the equilibrium is restored, when the radiation ceases.

What is the theory of Prevost?

Prevost supposes that all bodies, whatever be their temperature, are constantly giving out and receiving radiant caloric.

Which theory is the one most generally adopted?

The theory of Prevost is the one most generally adopted.

If they receive from surrounding bodies more than they radiate, what becomes of the temperature?

If they receive from surrounding bodies more than they radiate, the temperature becomes increased.

If they receive from surrounding bodies less than they radiate, what becomes of the temperature?

If they receive from surrounding bodies less than they radiate, the temperature becomes reduced.

What is cold?

Cold is a negative term, which merely implies an absence of caloric.

What is affirmed by some persons, in regard to the rays of the moon?

Some persons affirm that the rays of the moon are cold.

Has there been any experiments made to prove this?

A gentleman of Baltimore made a large glass bulb, which terminated in a long narrow tube, immersed in liquid. The bulb he painted black, so as to absorb as much heat as possible; he put this instrument in the

focus of the moon's rays, and found, to his great astonishment, that the liquid rose. He supposed that this experiment proved beyond doubt that the moon's rays were not cold.

Can this phenomenon be accounted for otherwise?

It can.

In what way?

The thermometer radiated more heat than it received, the earth being cool; and consequently its temperature became reduced.

How is the cooling of bodies effected?

The cooling of bodies is effected by the radiation and conduction of caloric.

LECTURE V.

RADIANT CALORIC CONTINUED.

On what does the formation of dew and frost depend?

The radiation of heat.

What is the earth, during the day, constantly absorbing?

The sun's rays, which become much heated.

At night, when this great source of heat is withdrawn, what becomes of the earth's temperature?

The earth radiates its heat, and not receiving as much as it radiates, its temperature is consequently reduced.

What are the effects of this reduction?

It condenses the moisture of the air in the form of globules of water, which settle upon the leaves and grass, and is called dew.

What theory furnishes a beautiful explanation of these curious facts.

Dr. Wells's.

Can you relate the theory?

"During the day, the various bodies on the surface of the earth, receiving the rays

of the sun, become warm; but at nightfall, when the sky is unclouded, they begin to cool; for the process of radiation continuing without any source of supply, their temperature must descend. While the sun shone, they received as much heat from him as they gave forth to the sky; but when he sets, the supply is cut off, and they therefore cool; and as there is always moisture, their temperature descending, by and by the dew point is reached; they become cold enough to condense water from the surrounding air, and this is the dew."

Can you tell me why a pitcher filled with cold water, or a bottle of wine taken fresh from the cellar (in summer particularly), will soon be covered with dew?

The bottle, being colder than the surrounding air, absorbs caloric from it: the moisture which that air contained becomes visible, and forms dew, which is deposited on the bottle.

At a still lower degree, the moisture of the air is condensed in a crystalline form, and is called what?

When the air is condensed in a crystalline form, it is called frost.

But why is there no dew or frost in a cloudy night?

The clouds stop the passage of the caloric which is radiated from the earth, and is

reflected back again : this increases the temperature of the earth, which is therefore too high for any condensation of the air to take place.

What is hoar frost?

Hoar frost is dew frozen the moment it falls.

Is the heat produced by the sun found to differ according to the surface exposed?

The heat produced by the sun is found to differ according to the surface exposed.

On what does the property of absorbing heat depend?

The property of absorbing heat depends on the color of the substance.

As a general rule, which colors absorb most light and heat?

Dark colors absorb most light and heat.

Can it be proved?

Dr. Franklin proved this, by laying pieces of cloth of different colors on snow. He exposed them during a given period to the sun's rays : he then noted the different depths to which, by the melting of the snow, the pieces sank; they consequently acquired heat in proportion to the darkness of their colors.

Is white a good dress for summer?

It is : the heat may be repelled.

Is a white dress good in winter?

It is good, because it radiates a little.

Is it a wise provision in our Heavenly Father to give the polar animals white fur?

It is: the fur of many animals changes color as the winter approaches.

LECTURE VI.

EFFECTS OF FREE CALORIC.

What are the general effects of caloric?

The general effects of caloric are, expansion, liquefaction and vaporization.

Does caloric expand all bodies?

Caloric expands all bodies, liquids more than solids, and gases more than either.

Does caloric expand solids?

Caloric expands solids.

Give an example.

A familiar demonstration of the fact may be afforded by adapting a ring to an iron rod, the former being just large enough to permit the latter to pass through while cold. The rod is next heated, and will then no longer pass through the ring.

Do equal additions of caloric expand some bodies more than others?

Equal additions of caloric expand some bodies more than others.

How is this proved?

By taking two glass bulbs terminating in long narrow tubes, one filled with alcohol, and the other with sulphuric acid.

If you immerse the bulbs in hot water, what will become of the alcohol?

If the bulbs be immersed in hot water, the alcohol will rise higher in the tube than the sulphuric acid, proving that its expansive power is the greater of the two.

Does caloric expand liquids more than solids?

Caloric does expand liquids more than solids.

Give an example.

Place a common thermometer into a jar of hot water. The bulb of the thermometer will be expanded, and its capacity increased; but the mercury will be more expanded, and rise in the tube.

Does caloric expand gases more than solids or liquids?

Caloric expands gases more than either solids or liquids.

How is it proved?

By taking a glass bulb terminating in a tube, the end of which is immersed in liquid, and heating it; then cooling it by means of pouring ether on it, we find that the liquid rapidly rises.

If you heat it again, what becomes of the air within?

When heated again, it expands and forces the liquid down.

The form which matter assumes, depends on what?

The form which matter assumes depends on the relative force of caloric and cohesion.

What effect has heat on bodies?

Heat expands bodies.

What does the absence of it do?

The absence of heat contracts bodies.

How long does water contract before it commences to expand?

Water contracts till the degree of 39 Farenheit's thermometer, when it commences to expand.

Is this a wise provision of nature?

This is a wise and benevolent provision in nature; for as the ice expands, it occupies more surface, and floats upon the water. If it contracts, in the course of a few weeks, all our rivers and lakes would be frozen entirely, and to such a depth that the summer's sun would have but little effect upon them.

When cohesion preponderates over caloric, what form does matter assume?

When cohesion preponderates over caloric, matter assumes a solid form.

When the force of caloric is greater, what becomes of it?

It becomes liquid or gas; and when the

excess of caloric is very high, it is always a gas.

What is it that determines the form of bodies?

Heat determines the form of bodies.

How can caloric affect our measures of time?

When the temperature rises, the rod of a pendulum lengthens, and its vibrations are made more slowly; the clock to which it is attached, loses time. When the temperature declines, the pendulum shortens; it beats too quick, and the clock gains.

Can this difficulty be obviated?

Many contrivances have been invented, such as the gridiron pendulum, &c.

Are all kinds of machinery affected by the law of expansion and contraction?

They are. M. Molard, a few years since, at Paris, availed himself of this principle, to restore to their perpendicular direction two opposite walls of a gallery, which had been pressed outward by incumbent weight. Through holes in the walls, several strong iron bars were introduced, so as to cross the apartment, with the ends projecting, upon which strong iron plates were screwed. The bars were then heated, and, while hot, the plates were screwed up. On cooling, the bars contracted, and drew the walls together. By repeating this process several

times, they were restored to their original position.

How were balloons first sent up?

Balloons were first sent up, filled with air which had been expanded by heat.

On what do the phenomena of winds depend?

The phenomena of winds depend upon the expansion of the air by the heat of the sun.

Where is one of the most ingenious and useful applications of this law to be found?

In an instrument called the thermometer.

LECTURE VII.

THE THERMOMETER.

How is the thermometer constructed;

Take a glass tube eighteen inches long, open at one end, and blown into a bulb at the other. The bulb is then filled with common air, and the tube is inverted into a cup containing some colored liquid, and the bulb grasped in the warm hand; the air within being expanded, will be seen bubbling up through the liquid. The air in the bulb, by its expansion, causes the water in the tube to sink; and by its contraction, the pressure of the atmosphere causes it to rise.

In what does the advantage of the air thermometer consist?

The advantage of the air thermometer consists in the great amount of the expansion of air, which, by a given elevation of temperature, is increased in bulk above twenty times more than mercury. Hence it is adapted to detect minute changes, which the mercurial thermometer would scarcely discover.

By whom was the air thermometer first made?

The air thermometer was first made by Sanctoria, of Padua, Italy, who lived about the beginning of the seventeenth century.

What objection was raised against it?

The air in the bulb, by its expansion, causes the water in the tube to sink.

How was it sustained?

The pressure of the atmosphere causes it to rise.

Has it been much improved?

The air thermometer has been very much improved.

The kind which are commonly used are filled with what?

The kind of thermometers in most common use are filled with mercury.

Are there any other kinds used?

There are several others.

What are their names?

Differential, Fahrenheit's, Mercurial, Reaumur's, Centigrade, &c.

Who constructed the differential thermometer?

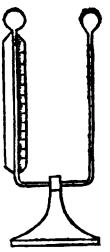
Mr. Leslie constructed the differential thermometer.

What is it used for?

The differential thermometer is used for determining differences of temperature at small distances.

How is it constructed?

Fig. 2.



It consists of two glass bulbs, joined together by a glass tube bent twice at right angles. The balls contain air, but the tube is filled with sulphuric acid colored with carmine. Upon applying either side to a heated body, the sulphuric acid will rise in the other side, different spaces, according to the different intensities of heat.

How are thermometers commonly constructed?

Thermometers are commonly constructed by taking a glass tube highly heated, and plunging it in mercury until it is entirely filled, and contains nothing but mercury. The tube is then sealed: two points upon it are then ascertained and marked, viz. the boiling point, found by plunging it into boiling water; and the freezing, by plunging it in a mixture of salt and snow. The space between is divided into 180 parts.

What is meant by the scale of a thermometer?

The scale of a thermometer is merely a flat plate placed behind the tube, and marked with small divisions to show what height the fluid rises.

By what name is this thermometer called?

Fahrenheit's.

Where is this thermometer most frequently used?

Fahrenheit's thermometer is most commonly used in America and England.

How is the Centigrade divided?

The centigrade is divided, between the two fixed points, into one hundred parts; the freezing point is 0°, and the boiling point 100°.

Where is the centigrade generally used?

The centigrade is generally used in France.

Where is Reaumur's scale used?

In some parts of Europe.

Under what circumstances are alcohol thermometers used?

Alcohol thermometers are used when very low temperatures have to be measured, such as approach or are below the freezing point of quicksilver: we resort to thermometers filled with alcohol, tinged with some coloring matter to make its movements visible.

But will thermometers bear any degree of heat?

No: for if the temperature were much above the highest degree marked on the scale of the thermometer, the mercury, by its expansion, would burst the tube; and no thermometer can, on any account, be applied

to a temperature higher than the boiling point of the liquid used in its construction; for on the liquid beginning to boil, the steam would burst the tube.

What instrument has been used for measuring degrees of heat higher than can be determined by thermometers?

A pyrometer.

How is a pyrometer constructed?

A pyrometer consists of a bar of platinum or soft iron, so placed, in a case of black lead earthen ware, that when exposed to a high temperature, the bar, expanding more than the case, pushes forward an index of porcelain.

Of what are they made?

Pyrometers are made of clay or platinum.

By what other name has it been called?

Wedgewood's Pyrometer, or fire measurer.

Whose pyrometer has been considered the best?

The pyrometer of Daniell, of London, is considered the best now in use.

LECTURE VIII.

LIQUEFACTION.

How is liquefaction produced?

Liquefaction is most generally produced by the direct application of heat.

If a solid be sufficiently heated, what will it become?

A solid, if sufficiently heated, will become liquid, and then gaseous.

What is the temperature at which liquefaction takes place, called?

The temperature at which liquefaction takes place, is called the melting point, or point of fusion.

What do bodies, in passing from a solid to a liquid state, absorb?

Bodies, in passing from a solid to a liquid state, absorb caloric.

Give an example.

If a pound of water at 32° be mixed with a pound of water at 172°, the temperature of the mixture will be intermediate between them, 102°; but if a pound of water at 172° be added to a pound of ice at 32°, the ice will quickly dissolve, and on placing a thermometer in the mixture, it will be found to stand, not at 102°, but at 32°.

In what two states does Dr. Black suppose heat to exist?

Dr. Black supposes caloric to exist in two states, latent or combined, and free or uncombined.

When a solid becomes liquid, what is supposed to become of its free caloric?

When a solid becomes liquid, he supposes a quantity of caloric combines with that substance, and thus becomes latent or insensible, and incapable of acting on the thermometer; and therefore liquefaction always takes place gradually. On the other hand, when a liquid is cooled down to a certain point, it parts with its caloric of fluidity, which now becomes sensible, and the liquid takes the solid form.

How many degrees of heat are absorbed during the liquefaction of ice?

About 140° of heat are absorbed by ice passing into the condition of water.

Into what are aeriform substances commonly divided?

Aeriform substances are generally divided into vapors and gases.

What appears to be the cause of vaporization?

Heat appears to be the cause of vaporization.

What is meant by vaporization?

Vaporization is the conversion of liquid and solid substances into vapor.

Into how many ways may liquids be vaporized?

Liquids may be vaporized in two ways.

What are they called?

Evaporation and ebullition.

What is evaporation?

Evaporation is the conversion of bodies into vapor at common temperatures.

What constitutes the difference between evaporation and vaporization?

Evaporation takes place quietly, and vaporization possesses the appearance of boiling.

The temperature at which a liquid is converted by ebullition into a vapor, is called what?

The temperature at which a liquid is converted by ebullition into a vapor, is called its boiling point.

Does the temperature at which liquids boil vary?

The temperature at which liquids boil varies greatly.

Give an example.

Place a small tube containing ether, in a mixture of sulphuric acid and water, and the ether will boil rapidly; but alcohol will

not, unless placed in the exhausted receiver of an air-pump.

As the pressure on liquids is diminished, what becomes of their boiling temperature?

It is diminished.

Give an example.

A flask placed over a lamp, and about three-fourths filled with water. After boiling a few minutes, it was corked tightly, and the water ceased boiling; but on plunging it in cold water, the boiling was renewed.

To what was the renewal of the ebullition owing?

The renewal of the ebullition is owing to the formation of a vacuum over the hot water, by the condensation of steam; and the suspension of boiling on the renewal of heat, to the pressure on the surface occasioned by the formation of fresh steam.

As the pressure on the surface of liquids increases, what becomes of their boiling temperature?

As the pressure on the surface of liquids increases, their boiling temperature increases.

When water is heated to the temperature of 212°, what is its force upon each square inch equal to?

Fifteen pounds.

This being equal to the pressure, what will it escape in?

Vapor.

Can it be heated in the open air above this point?

It can not be heated in the open air above this point.

But if the pressure be increased sufficiently, can it be heated to any extent, without exhibiting the phenomena of ebullition?

It can.

Give an example.

Boil water in a florence flask, and cork it tight; the ebullition will instantly cease, because the steam formed will press upon the surface; but by pouring on cold water and condensing the steam, it will boil violently. Pour on warm water, and it will stop boiling.

What are the chief circumstances which modify the boiling point of the same liquid?

The pressure of the atmosphere.

Does the pressure of the air retard ebullition?

The pressure of the air retards ebullition.

Can you prove that the pressure of the atmosphere prevents ebullition?

Place ether, alcohol, or boiling water under the receiver of an air-pump; then exhaust the air, and they will appear to boil.

Can you give another example?

A watch-glass, containing water, may be placed over a small vessel containing sulphuric acid, and put under the receiver. When the air is exhausted, vapor will freely rise from the water, and be quickly absorbed by the acid. A great degree of cold is thus produced, and the water will freeze.

Does the pressure of the atmosphere vary at different times on the surface of the earth?

It does: as we ascend high mountains, the pressure diminishes rapidly.

LECTURE IX.

THE BAROMETER.

What is the instrument called, by which the variation of the atmosphere is measured?

The barometer.

What is a barometer?

A barometer is an instrument used to measure air.

How is the barometer constructed?

Take a glass tube about 33 inches long, fill it with mercury, leave it open at one end, then immerse the open end in a cup of mercury; the pressure of the atmosphere on the surface will sustain the mercury in the tube to the height of from 27 to 31 inches.

What does the word barometer mean?

Barometer is derived from two Greek words, signifying a measurer of the weight, that is of the atmosphere.

Is the barometer of much importance?

The barometer is of great importance in a scientific point of view, and in the common concerns of life.

Is the human body able to sustain great degrees of heat?

Individuals have been known to expose themselves for several minutes in ovens, where meat was baking and water boiling, without suffering any inconvenience.

As a large quantity of caloric passes from a sensible to an insensible state, during the formation of vapor, what follows?

That cold should be generated by evaporation.

What experiment will prove this?

If a few drops of ether be allowed to fall upon the hand, a strong sensation of cold will be excited during the evaporation; or, if the bulb of a thermometer, covered with lint, be moistened with ether, the production of cold will be marked by the mercury.

Does the action of the cryophorus, a contrivance of Dr. Wollaston, depend on the same principle?

It does: it consists of two glass balls, perfectly free from air, and joined together by a tube. One of the balls contains a portion of distilled water, while the other parts of the instrument, which appear empty, are full of aqueous vapor, which checks the evaporation from the water, by the pressure it exerts upon its surface. But when the empty ball is plunged into a freezing mixture, all the vapor within it is condensed;

evaporation commences from the surface of the water in the other ball, and it is frozen in two or three minutes by the cold thus produced.

Is evaporation more rapid in some liquids than in others?

Evaporation is more rapid in some liquids than in others?

Does the increase of pressure check evaporation?

The increase of pressure checks evaporation, and the diminution of it promotes it.

What are some of the uses of evaporation?

Evaporation is fitted for cooling apartments, and tends to defend the animal as well as the vegetable system from external heat. Persons have been enabled to subject themselves to a very high temperature, and to a very low temperature, with but little inconvenience.

Would they have been enabled to do this, if the vital principle were destroyed?

They would not.

As soon as life becomes extinct, what form does the body assume?

The skin becomes green and livid, the eyes sink in their socket, and the body is then incapable of resisting either heat or cold.

Does the atmosphere contain any watery vapor?

to propel vessels by steam, he was considered as a fanatic ; but in the midst of all opposition he labored unassisted and alone, and persevered until he had conquered the prejudices and convinced the understandings of his fellow-men.

How had a distinguished poet foretold its success?

A distinguished poet foretold its success in the following beautiful manner :

" Soon shall thy arm, unconquered steam ! afar
Drag the slow barge, or drive the rapid car;
Or, on wide waving wings expanded, bear
The flying chariots through the fields of air."

Where was Robert Fulton born?

Robert Fulton was born at Little Britain, Lancaster county, Pennsylvania.

In what year?

In the year 1765.

The credit of the first successful experiment by propelling vessels by steam is due to whom?

The credit of the first successful experiment of propelling vessels by steam, is due to Robert Fulton, an American.

Has our communication to foreign countries been greatly enhanced through the accomplishment of steam navigation?

Our communications to foreign countries

have been greatly facilitated through the accomplishment of steam navigation.

When did the first steamship cross the Atlantic?

In the year 1819, a steamship called Savannah, built by Francis Ficket, at New York, and commanded by Commodore Rogers, sailed from thence with the object of making a voyage to England, France and Cronstadt, which was finally accomplished.

Has it become a mighty engine in the hands of Americans?

It has become the means which "has drawn the most distant parts of the Union near each other: the Mississippi and Missouri, the St. Lawrence and the Amazon, the Rhine and the Hudson, can be navigated with ease and certainty."

What does chemistry call forth?

Chemistry calls forth the hidden spirit of combustion.

When a piece of iron wire is lighted as a taper, and placed in oxygen gas, what effect does it produce?

When a piece of iron wire is lighted as a taper, and placed in oxygen gas, it burns with great brilliancy.

If certain portions of iron and sulphur be heated together, what effect does it produce?

If portions of iron and sulphur be heated together, it produces vivid combustion.

Of what is every instance of combustion a case?

Every instance of combustion is a case of chemical union, going on with such intensity of action as to produce incandescence.

What is the third source of caloric?

Condensation.

How did the savages often kindle their fires?

The savages often kindled their fires by rubbing pieces of dry wood against each other.

What does heavy machinery do, if not properly oiled?

Heavy machinery, if not properly oiled, often ignites wood.

What does the friction in these cases do?

Friction, in these cases, condenses the parts, and the caloric is developed.

What is the fourth source of caloric?

Vital heat.

What is the caloric developed by vital action supposed to be owing in part to?

The chemical action of the air upon the blood.

Of what does percussion and condensation cause the evolution?

Percussion and condensation cause the evolution of caloric.

Give an example.

Phosphorus and chlorate of potassa rubbed together, produce combustion.

What was the theory of Sir Isaac Newton respecting caloric?

Sir Isaac Newton supposed caloric a subtile material fluid, and that each minute indestructible atom of which it is composed is surrounded by alternating concentric hollow spheres of attraction and repulsion; and the admission of caloric does not expand the particles, but the spheres of attraction and repulsion.

LECTURE XIII.

LIGHT.

What is light?

Light is that principle or medium by which objects are made perceptible to our sense of seeing.

Does light travel with great rapidity?

The velocity with which light moves, is inconceivable.

How many minutes does it take light to travel from the sun to the earth?

Eight minutes.

When light falls upon a body, what becomes of it?

When light falls upon a body, it is either reflected, refracted or absorbed.

What is the angle of reflection always equal to?

The angle of reflection is always equal to the angle of incidence.

When rays of light pass from a rarer to a denser medium, as from air into water, what are they refracted toward?

When rays of light pass from a rarer to a denser medium, as from air into water, they are refracted toward a perpendicular.

When they pass from a denser to a rarer medium, what are they refracted from?

When rays of light pass from a denser to a rarer medium, they are refracted from a perpendicular.

Of how many kinds of rays is solar light composed?

Solar light is composed of three kinds of rays.

What are they called?

The calorific, the colorific, and the chemical rays.

What do the calorific rays produce?

The calorific rays produce heat.

What do the colorific rays produce?

The colorific rays produce color.

What do the chemical rays produce?

The chemical rays produce chemical decomposition among substances.

How many theories have there been respecting the nature of light?

There have been two theories respecting the nature of light.

What are they called?

The corpuscular and the undulatory theory.

Who was the author of the corpuscular theory?

Newton was the author of the corpuscular theory.

What was the corpuscular theory?

He thought that luminous bodies were constantly emanating particles of light, and that these particles were material.

What was the opinion of philosophers respecting the corpuscular theory?

They thought that if it were correct, that light must have some weight. In order to determine this, they placed 168 mirrors so as to concentrate all the rays which fell upon them to one point, where there was a scale which was turned by so delicate a weight as 0·03 part of a grain.

What theory has been formed by later writers?

The undulatory theory.

What is the undulatory theory?

The undulatory theory supposes that air is filled with an exceedingly subtile fluid called ether; that when any luminous body enters this fluid, undulations are caused, and these reach our eyes.

Does this theory seem to account satisfactorily for all the phenomena which we observe in light?

The undulatory theory seems to account satisfactorily for all the phenomena which we observe in light.

What else does this theory suppose?

The undulatory theory supposes that

color is nothing but the different degrees of pressure upon the optic nerve, and that the presence of light is not necessary for us to receive the sensation of color.

To whom are we indebted for the most important discoveries respecting light and colors?

Sir Isaac Newton.

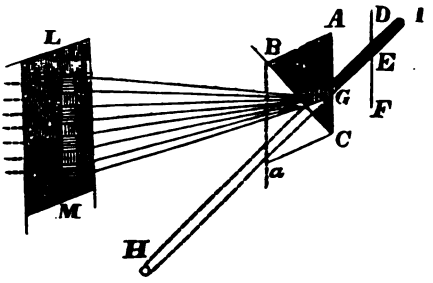
What did he do?

Sir Isaac Newton was the first person who divided a white ray of light: he also found that it contained many colored rays.

What was the instrument called, by which this separation was effected?

A triangular prism was the instrument by which this separation was effected.

Fig. 3.— A triangular prism.



Can you explain the method employed by Newton in the operation?

Newton's mode of operation consisted in admitting a ray of light IG (figure 3) into a dark room, through an aperture in a

window shutter DEF, and interposing the triangular prism ACB so that the ray might pass obliquely through two surfaces, and be refracted by both. On receiving the refracted ray upon a piece of white paper LM, there appeared, instead of a spot of white light, an oblong colored surface composed of seven different tints, called the prismatic or solar spectrum. On subjecting each of these colors to refraction, no further separation was accomplished; but on causing the rays separated by one prism to pass through a second of the same power, and in an inverted position CBa, the seven colors disappeared, and a spot of white light appeared at H in the very position which it would have occupied had both prisms been absent.

Of how many colors does Dr. Wollaston think the spectrum consists?

Dr. Wollaston supposes that the spectrum consists of four colors: red, green, blue, and violet.

What do these different colored rays, when collected by a lens into a focus, produce?

These different colored rays, when collected by a lens into a focus, produce a colorless light.

What is the instrument called, through which we exercise the sense of vision?

The eye is the instrument through which we exercise the sense of vision.

How is the eye constructed?

The eye is composed of two membranous coverings.

What are they called?

The cornea and sclerotica.

What do the cornea and sclerotica form?

These two coats together form a globe or ball.

What is contained within?

The iris, the humors of the eye, and the retina are contained within the coats.

What is the iris?

The iris is that colored circle which surrounds the pupil.

Why has it been so called?

For its variety of colors in different persons.

Has the iris more than one set of fibres?

The iris has two sets of fibres.

What are they called?

The circular and the radiating, which cross and act in opposition to each other.

When the circular fibres contract, what happens to the pupil?

When the circular fibres contract, the pupil is lessened.

When the radiating fibres contract, what effect does it produce?

When the radiating fibres contract, the pupil is enlarged.

What is the pupil?

The pupil is the opening in the iris, through which the light passes.

How many humors are there in the eye?

There are three humors in the eye.

What are they called?

The aqueous, the crystalline, and the vitreous humors.

What is the aqueous humor?

The aqueous humor is a fluid like water.

What is the crystalline lens?

The crystalline lens is a transparent body, in the form of a double convex lens, placed between the aqueous and vitreous humors.

What is the retina?

The retina is the seat of vision.

Of what does the retina consist?

The retina consists of an expansion of the optic nerve, which is perfectly white.

What is the optic nerve?

The optic nerve is the organ which carries the impression to the brain.

Fig. 4.— The Eye.

Can you explain figure 4?

Figure 4 represents a front view of the eye, in which AA represents the cornea, or, as it is commonly called, the white of the eye; II is the iris, having a circular opening in the centre, called the pupil, which contracts in a strong light and expands in a faint one, and thus regulates the quantity which is admitted to the tender parts in the interior of the eye.

LECTURE XIV.

TERRESTRIAL LIGHT.

Does terrestrial differ from solar light?

Terrestrial light differs from solar in several respects.

Does artificial light differ from solar?

Artificial differs from solar light, in containing heat in two states.

When have some substances the power of absorbing light?

Some substances have the power of absorbing light when exposed to luminous bodies; and when placed in the dark, they are phosphorescent.

Are there many substances in nature, which possess the property of shining in the dark?

There are many substances in nature, which possess the property of shining in the dark.

By what name are they called?

They are denominated phosphorescent.

What are the leading divisions of these substances?

Solar phosphori, phosphori from heat, and spontaneous phosphori.

What do you mean by solar phosphori?

Those which require a previous exposure to solar or other light, to become luminous; such are Canton's, Baldwin's, &c.

How is Canton's phosphorus prepared?

Calcine common oyster-shells in the fire for an hour; then select the purest and whitest parts, and reduce them to fine powder. Mix three parts of this powder with one of sulphur, and having pressed the mixture into a crucible, keep it red hot for one hour; then let the crucible cool, and select the brightest and purest parts, which cork up in a dry vial for use. When this composition has been exposed for a few minutes to the light of the sun, and then carried into the dark, it will be sufficiently luminous to show the hour by a watch-dial.

Can you give an example of phosphori by heat?

The yolk of an egg, when dried, becomes luminous on being heated; and so also do spermaceti, wax and tallow, during liquefaction.

Do some animal substances emit light?

This property is remarkable in some fish: the sea at times presents a magnificent and imposing spectacle.

How have some philosophers explained this phenomenon?

They have shown, that on a number of

occasions, this light was produced by a little animal called the glow-worm at sea.

Are the zoophytes and mollusca phosphorescent?

The zoophytes and mollusca are phosphorescent in a greater or less degree.

How have some philosophers accounted for the phosphorescence which is observed in the sea?

Some philosophers are of the opinion that it originates from the decomposition of vegetable and animal substances collected together in it, and which in putrifying emit their phosphorus.

Of what have some persons considered this the origin?

This has been considered by some persons as the origin of those ignes fatui which flutter at night over churchyards and fields of battle.

What kind of gas is often combined with phosphorus?

Hydrogen: it is not then fit for respiration; it quickly suffocates.

Is it ever necessary to measure light?

It is frequently found necessary to measure light.

What is the instrument called by which light is measured?

A photometer is the instrument by which light is measured.

How is it constructed?

It consists of a very delicate and small differential thermometer, one bulb of which is made of black glass, and the whole is enclosed in a small glass tube. The white ball transmits all the light and heat, and is of course unaffected; the black ball absorbs all the rays, and heats the air within so as to cause the liquid to rise.

What is the process of forming daguerreotype pictures?

Take a piece of silver, or copper plated with silver, well cleansed with nitric acid, and polished with great care with powdered pumice: then expose the plate a few minutes to the action of vapor of iodine, by which an exceedingly thin coating of iodide of silver is formed upon the surface. The plate is then placed in a camera obscura, and the image of any object in front is made to fall upon it for a few minutes, by which such a chemical change is produced in the thin coating of iodide of silver, that subsequent exposure to the vapor of mercury, at a temperature of from 160° to 165°, brings out a beautiful picture.

How is the picture, when taken from the mercurial process, rendered permanent?

The picture is rendered permanent by removing the coating of the iodide of silver, which is readily done, by merely pouring over it a warm solution of hyposulphate of soda or common salt.

LECTURE XV.

ELECTRICITY.

What is electricity?

Electricity is an invisible, subtile fluid, that appears to pervade all nature.

From what does it derive its name?

It derives it name from the Greek word *elektron* (amber), because the electric property was first discovered in this substance.

Give an example.

A dry glass tube, rubbed with a silk handkerchief, will attract a pith ball suspended by threads. Resins will also, by similar treatment, become capable of attracting and repelling light substances.

How is common electricity exited?

Common electricity is excited by the friction of one substance upon another.

How many kinds of electricity are there?

There are two kinds of electricity.

What are their names?

Positive and negative.

What is the positive?

The positive is that state of a body which contains more than its due proportion.

What is the negative?

The negative is that state of a body which contains less than its due proportion.

What has been supposed by philosophers respecting electricity?

That every body in nature possesses a certain degree of the electric fluid, which may be increased or diminished according to circumstances.

How many kinds of electrical machines are used?

There are two kinds of electrical machines used.

What are they called?

The cylindrical machine, and the plate machine.

Are all substances capable of exciting electricity?

All substances are not capable of exciting electricity.

The electric bodies which do not convey electricity from one body to another, are called what?

Electric bodies which do not convey electricity from one body to another, are called non-conductors.

The electric body which conveys fluid from one body to another, is denominated what?

Conductor is the name applied to the

Has any person ever been known to lose his life in this way?

Professor Richmann, of St. Petersburgh, was killed by lightning, on the 6th of August, 1753.

Can you relate the circumstances?

Professor Richmann had erected upon the top of his house, an iron rod, from which proceeded a chain, that entered his study. The whole apparatus was entirely insulated. He was examining the electrometer, as a thunder storm was approaching; a large globe of blue fire flashed from the conductor to his head, instantly depriving him of life.

LECTURE XVI.

THEORIES OF ELECTRICITY.

What was Franklin's theory respecting electricity?

Franklin ascribed the phenomena of electricity to the agency of one fluid. He supposed it a highly electric and imponderable fluid, which pervades all material bodies, and moves through them with various degrees of facility. He supposed bodies to be in their natural state with regard to electricity, when the repulsion of the particles of fluid is exactly balanced by the attraction of the matter for the same particles: when they contain a quantity greater than this, they are said to be positively electrified.

What was Dufay's theory?

Dufay supposes that there are two fluids: the one developed by the friction of the glass he called vitreous, which answers to the positive electricity of Franklin; and the other, developed by the friction of the wax, he called resinous, which corresponds with the negative electricity of Franklin. Each fluid repels itself, and attracts the other. It follows from this theory, that substances electrified by the opposite fluids attract each other.

What was Faraday's theory?

When a body is electrified by one fluid, it induces the opposite kind on those around it.

In storms, what do philosophers denominate the electricity of the clouds?

In storms, philosophers denominate the electricity of the clouds vitreous or positive.

What was the origin of the terms vitreous and resinous?

The terms vitreous and resinous were adopted, because glass, and other vitreous bodies, when rubbed, generally become positively electrified; while resinous substances are thus rendered negative.

Bodies similarly electrified, do what?

Bodies similarly electrified repel each other.

Bodies differently electrified, do what?

Bodies differently electrified attract each other.

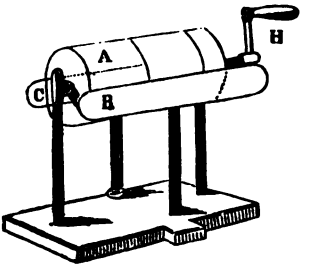
How is the experiment of the dancing images conducted?

By cutting several images in paper, and putting them between two metallic plates: the upper plate A is suspended by a chain from the prime conductor of the machine; the lower plate B is connected

with the ground. When the machine is turned, the images are attracted to the upper plate; but if they come in contact with it, they are repelled, and fall; but when they strike the lower plate, their electricity is discharged, and they are again attracted to the upper plate as before. They are thus made to dance about as currents of air may happen to move them, and thus form a very amusing experiment.

Fig. 5.

Fig. 6.—Electrical Machine as described in Gray's Chemistry.



Describe the electrical machine?

It consists of a cylinder, or plate of glass G, revolving on an axis, and subjected to the friction of a rubber R of leather or silk, upon which is spread a thin coat of amalgam composed of tin and mercury, insula-

ted by a glass pillar, and communicating with the ground by a brass chain, C. Attached to the machine is a cylindrical metallic conductor P, which is also insulated by a glass pillar. When the machine is in operation, vitreous electricity flows from the rubber or glass, by means of fine points, to the prime conductor P, and resinous electricity passes in an opposite direction. If the hand be placed upon the conductor, currents of electricity will pass in opposite directions; the vitreous passing into the body from P, and the resinous down the chain C to the ground. But if the hand be held at a little distance from the conductor, a spark will dart through the air, and cause a prickling sensation, accompanied by a slight report, with light and heat. The sound is produced by the collapse of the air, as the fluid forces a passage through it; and the light and heat are supposed to result from the sudden condensation of the air, as in the fire syringe.

What is said respecting conductors and non-conductors?

All those bodies which become excited by friction are non-conductors; for if they conducted freely, the fluid would pass off as quickly as it was excited. They are also called electrics, because they become excited, or electrified by friction. Conductors are also called non-electrics, because

they are not excited by friction; or, if excited for a moment, have their equilibrium restored by their conducting power.

Can electricity be transferred from the machine to the body?

It can, by standing on a stool supported by glass pillars : touch the prime conductor with one hand, and sparks may be drawn from any part of the body.

What is meant by induction?

Whenever a body, positively electrified, is made to approach another in its natural state, it always occasions or induces the contrary or negative state in the latter; and it is therefore said to be electrified by induction.

Describe the structure of the Leyden jar.

It consists of a glass jar, coated inside and out with a piece of tinfoil within an inch or two of its upper edge : a brass rod, terminated by a ball, passes through the cork which closes the mouth of the jar, and touches the inside coating.

In what way is it made to receive the electric fluid?

Present the knob to the prime conductor, and the electric fluid will be conducted down the wire, and distributed over the inner surface of the glass by means of the metallic coating. A large quantity of the

fluid can thus be accumulated, so as to give what is called a shock.

What is meant by an electrical battery?

When several Leyden jars are connected by their outer surfaces, and also by their inner surfaces, they constitute an electrical battery.

LECTURE XVII.

CAUSES OF ELECTRICAL EXCITEMENT.

Of what is the fire of St. Elmo generally considered an accumulation?

Electric matter around a point which moves in the air.

Where may this fire be expected to appear?

At the top of the masts of a vessel sailing along with rapidity.

By what name was this phenomenon known to the ancients?

This phenomenon was known to the ancients by the name of Castor and Pollux: many instances have been recorded by classic writers.

Relate an instance.

The preceding night in which Postumus gained the battle over the Sabines, the Roman javelins emitted a light like torches; and Cæsar relates that in the month of February, during the African war, there suddenly arose a dreadful storm, which threw the Roman army into great confusion, occasioned by the points of the darts of the fifth legion appearing to be on fire.

Relate the instance given by Count Forbin.

This extraordinary instance occurred in 1696, as related by Count Forbin. "In the night it became extremely dark, and thundered and lightened fearfully. We saw upon different parts of the ship about thirty St. Elmo's fires; among the rest was one upon the top of the vane of the mainmast, about eighteen inches long. I ordered one of the sailors to take the vane down; but he had scarcely removed it, when the fire again appeared upon the top of the mast, where it remained for a long time, and then gradually vanished."

How may a strip of gold leaf be oxidized?

A strip of gold leaf may be oxidized by pressing it lightly together between two pieces of white paper; then place it between the knobs of the discharger, so that they may be in contact with its opposite edges. After the discharge, the paper will be found stained of a purple color by the oxide of gold which has been formed.

Can you relate the experiment of the electrical sportsman?

From the larger ball of a Leyden jar, two birds, made of pith, are suspended by a linen thread, silk or hair. When the jar is charged, the birds will rise, on account of the repulsion of the fluid in the jar. If

The jar be then placed on the tinfoil of the stand, and the smaller ball placed within a half inch of the end of the gun, a discharge will be produced, and the birds fall.

What are the electrical bells designed for?

The electrical bells are designed to show the effects of electrical attraction and repulsion.

Relate the experiment of the thunder house.

The thunder house is designed to show the security afforded by lightning rods, when lightning strikes a building. A highly combustible material must be placed in the house, and a charge of electricity passed through it. A surface of tinfoil covers the floor. The hydrogen pistol must be placed on the floor of the thunder house, and connected with a wire on the opposite side. The house must then be put together, and a chain connected with the wire on the opposite side to the lightning rod, and the other end placed in contact either with a single Leyden jar or with the battery. When the jar thus situated is charged, if a connection be formed between the jar and the points of the lightning rod, the fluid will pass off silently, and produce no effect; but if a small brass ball be placed on the points of the rod, and a charge of electricity

be sent to it from the jar or the battery, the gas in the pistol will explode, and throw the parts of the house asunder with a loud noise.

In thunder storms, where does the electric fluid generally pass?

The electric fluid sometimes passes from the clouds to the earth, and from the earth to the clouds.

Is it unsafe to take shelter under a tree during a thunder storm?

It is not safe to take shelter under a tree, because the tree attracts the fluid; and the human body being a better conductor than the tree, the fluid leaves it, and passes into the body.

What constitutes lightning?

The excess of the fluid is discharged in the form of a flash.

Into how many kinds has lightning been divided by Arago?

Lightning has been divided by Arago into three kinds.

How are they distinguished?

They are distinguished, viz. zigzag lightning, sheet lightning, and ball lightning.

What do you mean by zigzag lightning?

Zigzag lightning derives its name from the peculiarity of its figure.

What is its appearance?

Zigzag lightning appears as a narrow jagged line of intensely vivid light, traversing space with great velocity. On account of the unequal conducting power of different portions of the atmosphere, the flash sometimes divides, branching out in several different directions: the lightning is then forked.

What is meant by sheet lightning?

Sheet lightning is the most common, and appears during a storm, illuminating the edges of the clouds.

Describe ball lightning.

Several instances are related by Brocklesby in his Meteorology. In a storm that happened at Steeple Aston, Wiltshire, in 1772, the Rev. Messrs. Pitcairne and Wainhouse, while in the vestry of the church, saw suddenly before them, at the distance of a foot, and at about their own height from the floor, a ball of fire, nearly the size of a man's fist, surrounded by a black smoke. It burst with an explosion like the discharge of several cannon. Pitcairne was dangerously wounded, and his person and clothes showed the usual marks of lightning. During a thunder storm that occurred in 1809, at Newcastle-upon-Tyne, the house of David Sutton was struck: the lightning descended the chimney. After

the explosion, several persons, who were assembled in a room, saw at the door a globe of fire, which, after remaining stationary for some time, advanced into the middle of the room, where it burst into fragments, with a report like a rocket.

What is the third instance?

On the fourth of November, 1749, in 42° 48′ N. lat., 2° W. lon., the crew of the ship Montague beheld, a little before noon, and beneath an unclouded sky, a globe of bluish fire, like a millstone, rolling rapidly upon the sea. At a short distance from the vessel, it rose perpendicularly from the water, and struck the masts with an explosion louder than the discharge of a hundred cannon. Five sailors were thrown senseless on the deck, one of whom was severely burned.

What is heat lightning?

We denominate that heat lightning which we witness in the serene evenings of summer.

LECTURE XVIII.

GALVANISM.

From what does galvanism derive its name?

Galvanism derives its name and owes its origin to the experiments of Galvani.

Who was Galvani?

Galvani was a professor of anatomy, in the university at Bologna, Italy, in the year 1790.

By what means did he discover the science of galvanism.

He was engaged in a series of experiments, with a view to prove that muscular action was intimately connected with electrical action. He observed that when a piece of zinc was placed in contact with the nerves of a frog, and a piece of copper with the muscles, the animal would be violently convulsed.

To what did he attribute this?

Galvani supposed the nervous fluid to be analogous to electricity, discharging itself from the muscles, in consequence of the conducting power of the metals.

How is the galvanic influence excited?

If a person place a piece of one metal, a twenty-five cent piece, above his tongue, and a piece of zinc below, he will perceive a peculiar taste; and in the dark, will see a flash of light, whenever the outer edges of the metals are in contact.

Who afterwards showed the fallacy of Galvani's theory?

Volta, professor of natural philosophy at Pavia, succeeded in pointing out the fallacy of Galvani's theory.

How did he prove it?

Volta proved by experiment that electricity is excited by the contact of the metals, and that the convulsion was owing to the current passing through the conducting muscles and nerves.

Who was the first that contrived an apparatus for exciting electricity in this way?

Volta was the first that contrived the voltaic apparatus.

By what name was the instrument called?

Voltaic pile.

How was it constructed?

The voltaic pile consisted of a great number of pairs of zinc and copper, with a layer of cloth interposed between them, and moistened by a solution of salt.

What was essential in this pile?

That the order of succession should be preserved.

What instrument is now used in preference to the pile?

The galvanic battery is now used in preference to the pile.

How is the galvanic battery constructed?

The galvanic battery is composed of two cylinders of copper and one of zinc, moistened with dilute acid. The zinc oxidates with the greatest degree of rapidity.

How was Cruikshank's trough (commonly called the galvanic battery), constructed?

Cruikshank's trough consists of a trough of dry wood, divided into cells by partitions placed at equal distances. Each partition is made of a plate of zinc and a plate of copper, previously soldered together, and fitted into a groove cut into the wood. The cells between the plates are to be nearly filled with water, having some nitric or other acid mixed with it.

How is the *couronne des tasses* described?

The *couronne des tasses* consists of a row of common tumblers or glasses, containing salt and water, or a saline fluid. Each glass contains a pair of plates; and each zinc plate is attached to the copper of the next

by a metallic wire, which is soldered to the plates.

By what other name has the couronne des tasses been called?

Couronne des tasses, in its literal application, means the crown of cups.

What has the battery of Dr. Hare been called?

The battery of Dr. Hare has been called a deflagrator.

What is the principle upon which the pile and galvanic battery were constructed?

The pile and galvanic battery were constructed upon the principle, that metals which oxidate with different degrees of rapidity, will, when immersed in dilute acid, cause the evolution of electric fluid.

When electric currents are caused to pass around soft iron bars, how do the bars become?

When electric currents pass around soft iron bars, they become magnetic.

When do the bars lose their power?

The bars lose their power when the current ceases.

To what has this fact been applied?

This fact has been applied to machinery.

LECTURE XIX.

EFFECTS OF GALVANISM.

What are some of the igniting effects of galvanism?

When the battery is in action, if two poles are connected by a small wire, it will become so heated, and give out a light so vivid, that the eye can scarcely endure it.

Can charcoal be ignited?

Charcoal emits an intense and brilliant light.

Can brilliant combustion be exhibited when placed on mercury, by means of the battery?

Take a dish, put a quantity of mercury in it, then connect it with the negative pole of a strong battery: whatever is to be subjected to experiment, attach to the positive wire, and make it touch the surface of the mercury. Fine iron wire burns in this manner with great rapidity, giving off vivid sparks, and producing an appearance like that of a brilliant star.

Does the color of the light vary in different metals?

The color of the light varies in different

metals. Gold leaf burns with a white light tinged with blue, and yields a dark brown oxide. Silver emits an emerald-green light, of great brilliancy; copper, a bluish white light, with red sparks; lead, a beautiful purple; and zinc, a brilliant white light, tinged with blue and red.

In what was the chemical effect of galvanism first noticed?

The chemical effect of galvanism first noticed, was in the decomposition of water, which is a compound of oxygen and hydrogen. When two gold or platinum wires are connected with the opposite poles of a battery, and their free ends plunged in the same cup of water, but without touching each other, oxygen gas is disengaged at the positive wire, and hydrogen gas at the negative.

Can these gases be collected?

These gases, when collected, will be found to consist of oxygen and hydrogen mixed in precisely the proportion for forming water.

How is the instrument formed for collecting the gases?

This little instrument consists of a bent glass tube. Through the two corks, platinum wires are passed, extending through the whole length of their tubes, and almost meeting each other at the angle. Each leg

of the instrument is corked air-tight, but at the bend is a small hole through the lower side of the tube. If this instrument be immersed in a vessel of water, and each of the wires connected with one of the poles of the galvanic battery, the two portions of the tube will be found to contain gas : that in the positive part will be oxygen; in the negative, hydrogen, and the hydrogen will be in bulk twice that of the oxygen.

Can this experiment be made to succeed, if two straight tubes, open at their lower end, are immersed in separate vessels of water?

The experiment succeeds equally well if the conducting wires are plunged into separate vessels or glass cups of water, and made to communicate with each other by moistened fibres of cotton. This important discovery led to similar trials upon other substances.

Can acids, salts and alkalies, be subjected to galvanic agency?

Acids, salts and alkalies were decomposed through the agency of galvanism; one of their elements appearing at the positive, the other at the negative pole.

Can a dry alkali, or an alkaline earth, be excited positively by contact with a metal?

A dry alkali or an alkaline earth may be

excited positively by contact with a metal· dry acids, after having touched a metal, are negative; and the contact of acids and alkalies, when dry, render the former negative and the latter positive.

By whom were these singular results first obtained?

These results were first obtained by Sir H. Davy: he made many useful applications of his theory. Thus, copper is rapidly corroded in acid, or saline solutions; but in contact with zinc, iron and some other metals, copper becomes electro-negative, and remains bright, while the other metal is rapidly deoxidized.

Have galvanic experiments ever been performed on dead bodies?

Galvanic experiments have been performed in dissecting rooms. Sometimes after galvanism has been applied, the subject has opened its eyes, and stared wildly around as if insensible of what was going on.

How many theories have been constructed to account for the phenomena of the galvanic pile?

There have been three theories to account for the phenomena of the galvanic pile.

Who were their authors?

Volta, Dr. Wollaston and Sir H. Davy.

Who did the first theory originate with?

The first originated with Volta, who maintained, that the electricity was set in motion and kept up solely by the contact of the metals; hence it has been called the electrical theory. The chemical theory, by Dr. Wollaston, is so called because it regards the chemical action which goes on in the pile, viz. the oxidation of the zinc: he was led to conclude that the process commences with the oxidation of the zinc, and that the oxidation is the primary cause of the development of electricity.

What does the electro-chemical theory of Davy suppose?

The electro-chemical theory of Davy supposes that the electric equilibrium is first disturbed by the contact of the zinc and copper plates, and that the excitement is afterwards kept up and increased by the chemical action between the liquid and the metal.

LECTURE XX.

MAGNETISM.

What is magnetism?

Magnetism is the name given to the unknown principle in some kinds of iron, which endows them with a power of attracting other pieces of iron. There appears to exist a substance or force of some kind or other, which exercises an influence probably over all terrestrial bodies, but which is chiefly shown as it acts upon the ore of oxidated iron, called loadstone.

How many kinds of magnets are there?

There are two kinds of magnets.

By what names are they called?

They are called natural and artificial magnets.

What may the earth be considered?

The earth may be considered as a great natural magnet, which, by its action on the needle, in the same manner as any other magnet, causes it to place itself in the position of north and south.

Are there any magnetic masses of iron in this state?

There are many magnetic masses of iron in the state of New York.

Are there any so naturally?

Yes: the loadstone is an ore of iron, found in iron mines.

Do all meteoric stones possess magnetic properties?

They do: nickel and cobalt, besides many fragments of iron ore, in which oxidation has taken place, possess this property.

How may bars of hardened iron be magnetised?

Bars of hardened iron may be magnetised by bringing them in contact with the magnet.

If the iron be extremely hard or exceedingly soft, what does it part with?

If the iron be either very hard or soft, it parts with its magnetism.

How many poles do magnetised bars present?

Magnetised bars present two poles, which are called the positive and negative.

What idea did Ampère suggest?

Ampère suggested the idea that there are two currents of electricity passing around all those bars that are magnetic.

Through what do the poles of a magnet exert their power?

The poles of a magnet exert their power through a vacuum.

Through what else do they exert their power?

Air and solids.

Where is the magnet used?

The magnet is used at sea.

To which direction does it always point?

The magnet always points to the north.

What is it convenient for?

Determining directions.

What has Mr. Sherwood proposed using it for?

Determining latitude and longitude.

What is the theory that accounts for the variation of the mariner's compass?

The theory supposes a large mass of melted magnetic iron revolving around the north pole, from east to west, or from west to east, and that this attracts the needle.

How often is it supposed to move around the pole?

It is supposed that this mass moves around the pole once in 666 years.

What is the magnetic meridian?

The magnetic meridian is a curved line going around the earth, in which line the magnet points directly north.

What did Sir Humphrey Davy suppose?

Sir Humphrey supposes that the atoms of all substances which unite, are in opposite states of electricity.

What has been noticed when a ship was struck with lightning?

That the magnetic needle often had its poles destroyed or reversed, and that the iron often becomes magnetic.

Describe a magnetic needle.

A light magnetic bar, so arranged that it can be poised on a pivot with freedom of motion, is a magnetic needle.

What is meant by its polarity?

The needle possesses polarity, or points north and south; a fact of the utmost importance in navigation.

What is the law of magnetic attractions and repulsions?

When to a needle the poles of a bar are approached, it exhibits attractive and repulsive movements. The law under which these take place, is "Like poles repel, and unlike ones attract; two north or two south poles repel, but a north and a south attract."

What is a horseshoe magnet?

When the two poles of a magnet are brought together in the form of a horseshoe, it is denominated a horseshoe magnet.

What is remote affinity?

Remote affinity is that kind which acts at sensible distances.

What is meant by contiguous affinity?

Contiguous affinity is that kind which acts at insensible distances.

Into how many classes is contiguous affinity divided?

Contiguous affinity is divided into two classes.

What are they called?

Homogeneous and heterogeneous affinity.

What is homogeneous affinity?

Homogeneous affinity is that kind which acts upon substances in nature which are alike, as the particles in a mass of lead or iron.

What is heterogeneous affinity?

Heterogeneous affinity is that kind which acts upon unlike substances.

Do we know anything of the nature of affinity?

We know nothing of the nature of affinity.

To what is our knowledge confined?

Our knowledge is confined to facts proved by experiment.

Are all substances subject to the laws of affinity?

What is a tetrahedron?

A tetrahedron is a solid bounded by four equilateral triangles.

What is a prism?

A prism is a solid, the sides of which are parallelograms, and the terminal planes are equal and similar figures.

What is a rhombic dodecahedron?

A rhombic dodecahedron is a solid bounded by twelve rhombic faces.

What is an isosceles triangular dodecahedron?

An isosceles triangular dodecahedron is a solid, bounded by twelve isosceles triangular faces.

What is a rhomb?

A rhomb is a solid bounded by six rhombic faces.

On what does the form of crystals depend?

The form of crystals depends upon their chemical constitution.

To how many may the primary forms of crystals be reduced by mechanical division?

By mechanical division, the primary forms of crystals may be reduced to three.

What are their names?

Tetrahedron, triangular prism, and rhomb.

LECTURE XXV.

CRYSTALLOGRAPHY CONTINUED.

By what name is the carbonate of lime, combined with carbonic acid, often called?

Carbonate of lime, combined with carbonic acid, is often called calcareous spar.

Is calcareous spar ever used as a building material?

Calcareous spar is frequently used in building.

In what part of the world is it greatly used?

Calcareous spar forms the ordinary building material in France.

By what name is it called when it crystallizes with a finer grain?

Marble, or calcareous freestone.

Which marble is esteemed the purest?

The white statuary marble, from Carrara, in Italy.

Of what are the colored marbles formed?

The colored marbles are formed of calcareous matter, mixed with extraneous substances.

Does every country abound with marble?

Pliny says that every country possesses its peculiar species of marble.

Where are crystals of carbonated lime found, under the name of calcareous spar?

Crystals of carbonated lime, under the name of calcareous spar, are found in almost every subterraneous cavity, and in all veins.

For what do they serve as ornaments?

They serve as ornaments for cabinets of mineralogy.

What varieties do phosphated and fluated lime exhibit?

Phosphated and fluated lime exhibit colored crystals.

What do colored crystals resemble?

Colored crystals resemble the precious stones, such as selenites, emeralds, rubies and others.

By what name is sulphated lime commonly called?

Sulphated lime is commonly known by the name of gypsum.

What is gypsum sometimes called?

Plaster of Paris is a common name for gypsum.

Are there many varieties of gypsum?

There are.

For what is gypsum extensively used?

Gypsum is extensively used for plastering rooms, stucco work, and for casts of statues, architectural models, &c.

Is gypsum ever used by printers?

Gypsum is indispensable in stereotyping.

Is gypsum ever used by the agriculturist?

Gypsum is extensively used by the agriculturist in fertilizing the soil.

When crystallized, what is it called?

When gypsum is crystallized, it is known by the name of selenite.

Can selenite be divided?

Selenite can be divided into brilliant and transparent laminæ.

How was selenite used by the ancients?

Selenite was used by the ancients in place of glass for windows.

Can the crystallization of substances be effected by more than one process?

The crystallization of substances can be effected by various processes.

Give an example.

If a quantity of sulphur is melted, then allowed to cool slowly, then break the crust, and pour out what remains a liquid, a mass of crystals will be found shooting in every direction.

Does crystallization ever take place in solids?

Crystallization frequently takes place in solids.

Give an example.

Common wire, which has been kept a long time, loses its tenacity, in consequence of cubic crystals of the metal gradually forming in it.

LECTURE XXVII.

NON-METALLIC AGENTS.

Into what are the ponderable agents divided?

The ponderable agents are divided into non-metallic and metallic.

Which is the first of the non-metallic agents?

The first of the non-metallic agents is oxygen.

By whom was oxygen discovered?

Oxygen was discovered by Dr. Priestley, of England.

In what year?

In the year 1774.

By what name did Dr. Priestley call it?

Dr. Priestley gave it the name of dephlogisticated air.

What name did Scheele give it?

Scheele gave it the name of empyreal air.

By what name did Condorcet call it?

Condorcet called it vital air.

Why did he call it vital air?

He called it vital air, because it is a supporter of animal life.

From whom did it receive the name of oxygen?

It received the present name of oxygen, from Lavoisier.

From what is the name oxygen derived?

The name oxygen is derived from two Greek words, which signify a generator of acids.

What are some of the physical properties of oxygen?

Oxygen is a transparent, inodorous and tasteless gas.

In how many states does it exist in nature?

It exists in nature in three states: solid, liquid, gas.

When combined with iron, what is it called?

If combined with iron, it is called iron rust.

How can oxygen be obtained?

Oxygen may be obtained from the black peroxide of manganese, by applying heat to it. It may also be obtained when heat is applied to chlorate of potassa: this is much purer, but more expensive.

Is oxygen one of the elements of air?

It is: the atmosphere consists of 78 parts of nitrogen, 21 of oxygen, and 1 of carbonic acid or fixed air.

What are some of the properties of oxygen?

Oxygen is a supporter of respiration and animal life. None can live without it. A few years since, 148 persons were confined in a prison 18 feet square, called Black Hole, in Calcutta, for a single night. There were only two very small windows in one side of the prison, by which air could be admitted; and in the morning when the hole was opened, only twenty-three were found alive; the oxygen during the night had become exhausted, and thus caused their death.

What frequently causes persons to faint, when in a crowded room?

The oxygen has become nearly exhausted, the air impure and vitiated, and thus giddiness, fainting, and a difficulty of breathing are the results.

After we have respired the air, does it become greatly changed?

It does: carbon being one of the elements, unites with the oxygen, and thus forms carbonic acid.

Fig. 7.

How can you show that we breathe out carbonic acid gas?

Fill a tumbler with pure, clear lime water, and take a small glass tube, or straw, and blow through it: the whitening of the water will show the amount of carbon in the breath.

LECTURE XXIX.

NITROGEN.

By whom was nitrogen first discovered?

Nitrogen was first discovered by Dr. Rutherford, of Edinburgh, in the year 1772.

Was it discovered by any other persons?

Yes. Lavoisier and Scheele discovered it several years after.

What name was it called by Lavoisier?

It was called by Lavoisier, azote, because it deprived animals of life.

From what is its present name derived?

Its present name is derived from nitre.

Where is nitrogen found?

Nitrogen constitutes four-fifths of the atmosphere, and enters into the composition of animals. It is found extensively in large caverns of Kentucky. It is given off by the hot springs of Scotland, and the Lebanon springs in the State of New York.

How can nitrogen be obtained?

Nitrogen can be obtained by burning a piece of phosphorus in a jar of air inverted over water; the phosphorus unites with the oxygen of the air and forms phosphoric

acid, which is absorbed by the water, and thus the nitrogen is left perfectly pure.

What are some of the physical properties of nitrogen?

Nitrogen is a colorless, tasteless and inodorous gas; it does not support combustion or animal life: it possesses some remarkable properties of preserving.

When united with oxygen, in the proportion of five to one, what does it become?

When nitrogen is united with oxygen in the proportion of five to one, it becomes a supporter of animal life; in every other proportion, it is destitute of this quality.

When united with hydrogen, what does it form?

When nitrogen is united with hydrogen, it forms ammonia, a salt which is found on the banks of the Nile.

What other names have been applied to ammonia?

Ammonia has received the names of hartshorn, spirits of hartshorn, &c.

Is ammonia extensively used?

It is used extensively by the chemist to neutralize acids. Colors changed by sulphuric or any other acid, may often be restored by ammonia.

Is ammonia ever used by the physicians?

Ammonia is used in medicine as a tonic;

it is the substance employed for smelling bottles.

Has it ever been found injurious?

Orfila adds a caution against its too frequent use with persons who have fainted. If they breathe it too long, the vapor inflames the throat and lungs, and thus produces death.

LECTURE XXX.

OXIDES AND ACIDS.

When oxygen unites with nitrogen, what does it form?

Oxygen combined with nitrogen, forms air.

When oxygen unites with hydrogen, what does it form?

Oxygen combined with hydrogen, forms water.

Will oxygen combine with almost any substance?

Oxygen will combine with most of the elementary substances.

When a small proportion of oxygen is

joined with another element, what name is given to the compound?

The compound is called an oxide, of oxygen.

What is nitrous oxide?

It is the smallest quantity of oxygen that will combine with nitrogen.

By what other name is it frequently called?

Nitrous oxide is called laughing gas.

Who first investigated the effect which it produces upon the human system?

Sir H. Davy, in the year 1799.

What effect did he find that it produced upon the system?

The effect varies much according to the temperament of the person who inhales it. In some persons it produces great laughter, a rapid flow of vivid ideas, and an unusual disposition to muscular exertion. These feelings subside in a few minutes, and in general are not followed by any thing more than a slight sensation of languor; but the results produced by it sometimes are injurious.

When a large quantity of oxygen combines with another element, what name is given to the compound?

The name given to the compound is acid.

What is nitric acid?

Nitric acid is the greatest quantity of oxygen that will unite with nitrogen.

When, and by whom was nitric acid discovered?

Nitric acid was discovered about 1225, by Raymond Lully.

What are some of the properties of nitric acid?

Nitric acid is an odorous and poisonous liquid: it acts powerfully on substances which are disposed to unite with oxygen.

Is nitric acid of any use in the arts?

Nitric acid is used extensively in the arts: for etching on copper; as a solvent of tin, to form a mordant for some of the finest dyes; and in medicine, as a tonic.

What is the nitric acid of commerce frequently called?

There are two kinds of nitric acid of commerce: the one, $\frac{1}{3}$ of water, and is called double aqua fortis; another kind, $\frac{2}{3}$ water, is called simply aqua fortis, which is half the strength of the double.

LECTURE XXXI.

CARBON.

Is carbon an important and useful substance?

Carbon is very useful, and exists abundantly in the animal, vegetable and mineral kingdoms: it is rarely found perfectly pure in nature.

In what is the only pure carbon found?

The only pure carbon is found in the diamond.

Where is the diamond found?

The diamond is found in many parts of the East Indies, Brazil, and it is also found in diluvium.

Are diamonds of various colors?

Diamonds have been found of nearly every color, but the colorless diamonds are considered the most valuable.

What is the hardest body in nature?

Diamond is the hardest body in nature.

What are some of the other kinds of carbon?

The other kinds of carbon are plumbago,

anthracite, bituminous coal, peat, lampblack, ivory black, charcoal, &c.

What is plumbago?

Plumbago is nearly pure carbon; it is frequently called blacklead, and is used for pencils, crayons, &c. Crayons are extensively used for drawing.

What is anthracite?

Anthracite is a species of coal which is used in many parts of the United States; it is found in Pennsylvania, and in the southeastern part of Massachusetts : it is one of the densest and purest varieties of mineral coal.

What is peat?

Peat is a vegetable substance, and is generally dug from swamps; but when dry, it is often used for fuel where better can not be obtained.

What is lampblack, and how is it obtained?

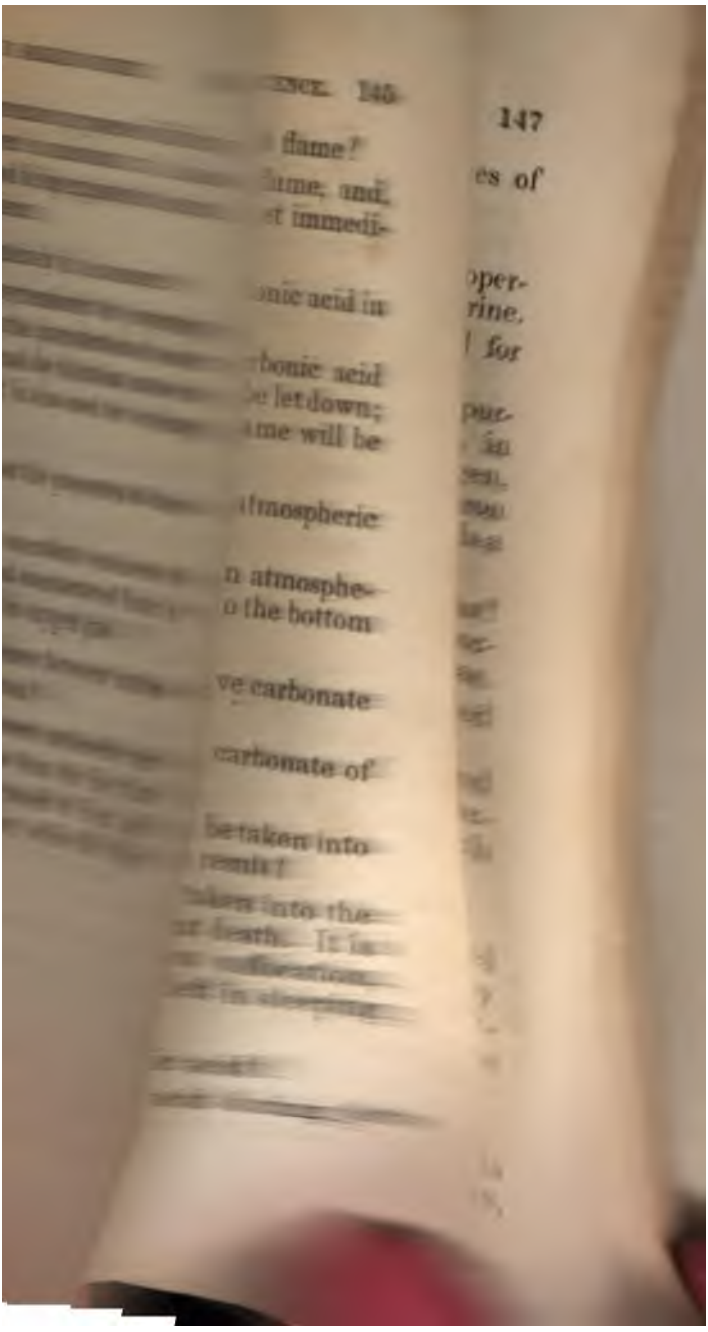
Lampblack is a species of carbon, and is obtained by the burning of turpentine, pitch pine, &c.

What is ivory black?

Ivory black is an animal charcoal, and is obtained by burning bones excluded from air.

What is charcoal, and how is it obtained?

Charcoal is a species of carbon, and is



LECTURE XXXII.

CARBONIC ACID.

Where is carbonic acid found?

Carbonic acid exists in nature, and is obtained by burning charcoal in the air, or in oxygen.

What are some of the properties of carbonic acid?

It is a colorless, inodorous and elastic fluid.

What causes the effervescence which takes place on opening a bottle of beer?

The carbonic acid gas escapes, and this causes the effervescence which takes place on opening a bottle of beer.

Is carbonic acid gas ever found in the atmosphere?

Carbonic acid is always found in the atmosphere.

Can you give an example?

Carbonic acid and lime have a strong attraction. If there be carbonic acid in the air, a little water being poured into an empty flask filled with atmospheric air, and being shaken up, it will become slightly turbid, and have a milky appearance.

Does carbonic acid extinguish flame?

Carbonic acid extinguishes flame, and, when heated, destroys life almost immediately.

How can the presence of carbonic acid in a well be detected?

To detect the presence of carbonic acid in a well, a burning candle may be let down; and if it continues there, the flame will be extinguished.

Is carbonic acid heavier than atmospheric air?

Carbonic acid is heavier than atmospheric air, and consequently sinks to the bottom of wells.

Does carbonated water dissolve carbonate of lime?

Carbonated water dissolves carbonate of lime.

If pure carbonic acid should be taken into the lungs, what would be the result?

Pure carbonic acid, when taken into the lungs, produces almost instant death. It is this gas which often causes suffocation, when pans of hot coals are left in sleeping rooms.

Do plants absorb carbonic acid?

Plants absorb carbonic acid during the daytime.

What does carbon, when united with hydrogen, form?

Carbon, when united with hydrogen, forms an inflammable gas.

When carbon is united with oxygen, what does it form?

Carbon, when united with oxygen, forms an explosive mixture.

Carbon, when united with nitrogen, forms what?

Carbon, united with nitrogen, forms cyanogen.

LECTURE XXXIII.

CARBURETTED HYDROGEN.

By what names is carburetted hydrogen sometimes called?

Carburetted hydrogen is sometimes called inflammable gas, olefiant gas, and subcarburetted hydrogen.

What kind of gas is now generally employed for the purposes of illumination?

Mixed gas, composed mostly however of

olefiant, is chiefly used for the purposes of illumination.

Why was it called olefiant gas?

It was called olefiant gas from its property of forming an oil-like liquid with chlorine.

When was coal gas first introduced for purposes of illumination?

Coal gas was first introduced for the purposes of illumination by Mr. Murdock, in 1792. Coal furnishes carburetted hydrogen, by being distilled at red heat in large iron retorts. The coal at Richmond, Va., yields a large quantity of gas.

Has oil gas any advantages over coal gas?

Oil gas contains a much greater proportion of carburetted hydrogen than coal gas.

What has in a great measure prevented the use of gas lights?

The expense of gas-works has prevented their use; but within a few years past, arrangements have been made by which whole cities are lighted with gas.

What is the gasometer?

The gasometer is a large inverted vessel made of iron. The gas is introduced by pipes ascending from the bottom of the reservoir, and rising a little above the surface of the water.

What is meant by fire damp?

In coal mines, an inflammable gas is generated, called fire damp by the miners,

and is composed of several gaseous compounds of carbon and hydrogen. This gas, when mixed with atmospheric air, is liable to take fire from the flame of a lamp or candle : it is this which causes such frequent explosions in the mines. These accidents, which were formerly so frequent and fatal, are now comparatively rare, owing to the employment of the safety lamp.

To whom are we indebted for the safety lamp?

We are indebted to Sir Humphrey Davy for the safety lamp.

How is it constructed?

It is so constructed that the lamp will show when there is any hydrogen in the atmosphere; and the miners, perceiving it, can hastily escape. It consists simply of a lamp, the flame of which is wholly enclosed in a cylinder of fine wire gauze, which allows the hydrogen to pass through. The wire gauze, being a powerful conductor and radiator of heat, cools a flame which is in contact with it, so as to deprive it of the power of producing an explosion on every side.

What will be the result, if this lamp be immersed in an explosive mixture?

If this lamp be immersed in an explosive mixture, the gas will be inflamed, and burn on the inside of the gauze cylinder, but not on the outside.

LECTURE XXXIV.

SULPHUR.

Is sulphur a simple or compound substance?

Sulphur is a simple inflammable body, of a light yellow color.

Where is sulphur found in a pure state?

Sulphur is found in a pure state in craters of volcanoes, in regular crystals; and in combination with various metals, as, for instance, antimony, iron and copper, forming sulphates.

How is sulphur separated from the metals?

Sulphur is separated from the metals by heat : it melts at 220°, and takes fire at 500° Fahrenheit.

Has pure sulphur any odor?

Pure sulphur has no odor, except that which is supposed to arise from its impurities.

How many forms has sulphur?

Sulphur has two forms : the flowers of sulphur ; and the roll, commonly called brimstone.

Which is the most pure?

The flowers of sulphur is most pure.

Is sulphur a non-conductor of electricity?

Sulphur is a non-conductor of electricity; but when excited, it will attract light substances.

Is sulphur an acidifiable substance?

Sulphur is an acidifiable substance when united with nitrate of potassa, and inflamed under a bell-glass.

Will the oxygen of the nitric acid unite with the sulphur?

The oxygen of the nitric acid will unite with the sulphur, and form sulphuric acid.

What are some of the uses of sulphur?

Sulphur is extensively employed in the manufacture of sulphuric acid; in that of gunpowder : it is used to form moulds for plaster casts, for taking impressions of seals, &c.

Is it ever employed in medicine?

In medicine it is employed both as an external and internal remedy, especially in diseases of the skin.

Does sulphur contain any earthy impurities?

Sulphur contains many earthy impurities?

How can the impurities of sulphur be tested?

Heat sulphur on a piece of platinum leaf; if impure, the sulphur will evaporate and leave the earthy substance.

Is pure sulphur soluble?

Pure sulphur is perfectly soluble in boiling oil of turpentine, which is one of the tests of its purity.

Is arsenic ever found in sulphur?

Arsenic is sometimes found in sulphur.

Can sulphur be crystallized?

Sulphur may be crystallized by fusing several pounds of it in a large crucible, and allowing it to cool slowly.

What are some of the properties of sulphurous acid gas?

Sulphurous acid gas is fatal to animals, when confined in it: it is not combustible, but extinguishes burning bodies. It possesses the property of bleaching, and is used for that purpose; thus straw bonnets are bleached by the fumes of sulphur.

What is the process of bleaching straw?

Take a plate of sulphur, and place it in the bottom of a barrel which contains the article; then set the sulphur on fire, and this produces sulphuric acid; then by keeping the barrel covered, the acid will bleach the straw.

What effect has sulphurous acid upon the colors of vegetables?

If sulphurous acid be applied to vegetable colors, it will turn blue to red, and will destroy red entirely.

Which is the strongest, sulphurous or sulphuric acid?

Sulphuric acid is the strongest.

Does sulphuric acid ever occur free in nature?

Sulphuric acid occasionally occurs free in nature.

LECTURE XXXV.

PHOSPHORUS.

What is phosphorus?

Phosphorus is a simple inflammable body, usually obtained from animal bones. At 148° Fahr. it takes fire, and burns with great brilliancy.

When and by whom was phosphorus discovered?

Phosphorus was discovered in 1669 by Brand, an alchemist of Hamburgh; but the secret of obtaining it remained a considerable length of time.

From what did phosphorus receive its name?

Phosphorus received its name from the property it possesses of shining in the dark.

Are there many amusing experiments performed by means of phosphorus?

There are a great many amusing experiments performed. For instance, words or figures drawn on the wall of a dark and warm room with a stick of phosphorus, will leave traces which at night look like fire.

What are some of the properties of phosphorus?

When pure, it is transparent, and easily cut with a knife.

Why should phosphorus be kept under water?

Phosphorus has such a strong affinity for oxygen, that it takes fire at a common temperature.

Is phosphorus poisonous?

Phosphorus is very poisonous, but it is used sometimes as a medicine.

Is phosphorus much used in the arts?

Phosphorus is not much used in the arts. Matches are, however, made of it, which ignite by slight friction.

What is the process for obtaining phosphorus?

The process for obtaining phosphorus is to ignite bones in an open fire till they become white, so as to destroy all the animal matter they contain, and oxidize the carbon proceeding from its decomposition.

LECTURE XXXVI.

CHLORINE.

By whom was chlorine first discovered?

Chlorine was first discovered by Scheele, in 1774.

From what does it derive its name?

Chlorine derives its name from the Greek *chloros*, green, in allusion to its color.

What are some of its properties?

Chlorine is of a yellowish green color, and has an astringent taste and disagreeable odor: it emits light and heat when strongly compressed; and is one of the most suffocating of the gases, exciting spasm and great irritation of the glottis, even when considerably diluted with water.

Is it a simple or compound substance?

Some suppose it to be a simple, others a compound substance; both theories are, however, well supported.

Is chlorine a supporter of combustion?

Chlorine is a supporter of combustion: if a lighted taper be plunged into a vessel of chlorine gas, it burns brilliantly.

Are any of the metals inflamed when introduced into it?

Several of the metals, such as tin, copper,

arsenic, antimony and zinc, are suddenly inflamed when introduced into it.

What is one of the most important properties of chlorine?

One of the most important properties of chlorine, is that it possesses the power of bleaching.

Give an example.

If a strip of calico be introduced into a solution of the chlorine, colors will soon be completely discharged.

Is chlorine a powerful disinfecting agent?

Chlorine is a powerful disinfecting agent.

On what does this power depend?

This power depends on its great affinity for hydrogen. It decomposes every species of animal and vegetable effluvia: hence its utility in contagious diseases.

Do you remember any other uses to which chlorine has been applied?

Chlorine has been found very useful in dissecting rooms, and the chlorate of lime is frequently used for cleansing the apartments of the sick; it also purifies the air when charged with miasma.

Should the apartment in which chlorine of lime has been used for cleansing, be ventilated before it is again occupied?

The apartment should be thoroughly ventilated before it is again occupied, or

persons who have weak lungs may be seriously injured.

Where is chlorine chiefly found?

Chlorine is chiefly found in the ocean, and in the rock salt dug out of the earth.

Is chlorine destructive to animal life?

Chlorine is very destructive to animal life: a few bubbles of gas in the atmosphere of a room will bring on coughing. Pelletier is said to have fallen a victim to its effects. The antidote is ammonia.

What are some of the tests of chlorine?

Chlorine is detected by its bleaching properties, color and odor.

LECTURE XXXVII.

CHLOROFORM.

By what name has chloroform been known?

Chloroform has long been known under the name of Dutch oil, or oil of the Dutch chemists.

From what is its name derived?

Its name is derived from its being discovered by an association of Dutch chemists at Harlaem in 1796; who also discovered, at the same time, bicarburetted hydrogen.

If a stream of chlorine gas is introduced into a glass receiver containing bicarburetted hydrogen, what is the product, and by what name is it called?

If a stream of chlorine gas is introduced into a glass receiver containing bicarburetted hydrogen, an oily compound is produced, which is the oil of the Dutch chemists: from this circumstance, the bicarburetted hydrogen was called by them olefiant gas.

Are the terms chloric ether, bichloric ether, perchloride of formyle, Dutch oil, and oil of the Dutch chemists, synonyms of chloroform?

The terms chloric ether, bichloric ether, perchloride of formyle, Dutch oil and oil of the Dutch chemists, are all synonyms of chloroform, which term was first used by Dumas; expressing, as he states, the relation this substance bears to formic acid, or its hypothetical radical formyle.

By the action of bleaching powders on alcohol, aided by heat, a substance was discovered, analogous in every respect to chloroform, and in fact is the chloroform. This effect was discovered almost simultaneously by Mr. Samuel Guthries of Sackets Harbor, N. Y., and M. M. E. Soubeiran of France.

What is the process, as taken from Silliman's Journal of March 1848, page 241?

The following is the process, as taken from Silliman's Journal: "About six pounds of dry bleaching powder (chloride of lime) was introduced into a copper still containing about four gallons of water, and of a capacity equal to ten or twelve gallons: half a gallon of common alcohol (80 per cent.) added; the materials thoroughly agitated, and a cautious distillation commenced. A powerful condensing apparatus is attached, and very soon the dense globules are seen coming over dropping into the water. The larger portion of the fluid is given off before the heat is intense enough to distil over much alcohol. It would be advisable to change the receiving vessel as soon as the process is supposed to be about half done, as the first portions are the richest; and if allowed to mingle with the second portion, the product of the distillation is much smaller, because a very small portion of alcohol will dissolve a very large quantity of chloroform. The product of the distillation is washed with cold water, which washing is continued until no further diminution of chloroform is observed: it is then fit for medicinal purposes. The 'caput mortuum' in the still is not capable of producing any appreciable effect on the addition of more alcohol."

The solution of chloride of lime and alcohol remaining in the still, deposit, on

standing, an abundant crop of delicate acicular crystals, whose composition has not yet been examined.

The above proportions yield about 6 or 8 ounces of pure chloroform.

Chloroform thus prepared, possesses what properties?

Chloroform thus prepared, has the following properties: Sp. gr. 148; boils at 141° F., and is not inflammable; but according to Soubeiran, its vapor, when directed from a jet in alcohol blaze, burns with much smoke. It is an oily volatile, perfectly pellucid, sweet aromatic taste, and of fragrant odor.

Does it burn when mingled with alcohol?

It burns when mingled with an equal volume of alcohol.

Does it dissolve iodine?

It dissolves iodine. Potassium decomposes it at low temperatures, forming chloride of potassium (common salt), disengaging hydrogen and carbon. It is decomposed by oxide of barium and oxide of calcium, metallic chlorides being produced, and carbon and hydrogen given off.

Does sulphuric acid act on it at common temperatures?

Sulphuric acid does not act on it at common temperatures.

Does hydrochloric acid change it at high temperatures?

Hydrochloric acid does not change it at high temperatures. Nitric acid heated with it, a small quantity of nitrous acid is disengaged. Solution of potash produces a slow decomposition.

By what name has the compound chloroform been called?

Chloroform has been called chloric ether.

Is that term inappropriate?

The term chloric ether is inappropriate, as this curious substance bears no analogy to the ethers. Chloric ether is more properly applied to the perchloric described by Booth and Boyé, which possesses a very violent explosive power.

Does the class of ethers possess properties common to chloroform?

The class of ethers possess properties not common to chloroform; for instance, a *watery solution of potassa* promptly decomposes the ethers, taking up O_2, and forming alcohol and chlorine; but no action of so extended a decomposition is manifest in the case of chloroform.

Are iodoform and bromoform analogous to chloroform?

Iodoform and bromoform are compounds strikingly analogous to chloroform. All are acted on and decomposed by an *alcoholic* solution of potassa, affording a compound

f the salt radical with potassium, and also ormate of potassa.

Does chloroform give any perceptible trace of that element, when treated with nitrate of silver?

Chloroform, though containing 83 per cent. of chloriform, does not give any perceptible trace of that element when treated with nitrate of silver; a result which will not be considered anomalous, if we apply to it the law, which governs all similar substitutions, with regard to products in which the *electro-negative element exists in an electro-positive allotropic condition.*

What is this substance named by Graham?

By Graham, chloroform is named bichlorinated methyl, which term undoubtedly expresses in full its chemical constitution; for the fourth equivalent of hydrogen which it contains may be replaced by exposing chloroform to the action of chlorine, in the sun's rays; the result will be chloride of carbon, or perchlorinated methyl.

M. I. Isidore Pierre, in an article ("Sur un nouveau dérivé chloric de la liqueur des Hollandais"), gives a new compound derivative of Dutch oil. His views of the Dutch liquid, however, are different from Mr. Silliman's.

What is the action of chloroform on the animal economy?

Chloroform, in its action on the animal economy, resembles sulphuric ether. Its vapor, being inhaled, produces a complete paralysis of the nerves of sensation; taken in large quantities, death is the consequence, preceded by coma and general prostration of all the nervous energy.

What renders the use of chloroform important in medicine?

It is the power of inducing a complete absence of sensation, that has given it its important place for medicinal uses; it is also very analogous in its effects to nitrous oxide, causing death when inhaled in too large quantities.

Has chloroform been used for inducing insensibility to pain?

Chloroform has been extensively used as an agent for inducing insensibility to pain; and though but very few cases have occurred in which it was injurious, still much care should be exercised in administering it.

Have any cases of death occurred from its use?

Several cases of death having occurred from its use, it is more restricted in its application. Of its modus operandi on the system, we can say nothing, or at most but very little, and that little of but limited use as yet on which to hazard an opinion.

LECTURE XXXVIII.

IODINE, BROMINE, FLUORINE AND SELENIUM.

When and by whom was iodine discovered?

Iodine was discovered in 1812, by M. Courtois, a manufacturer of saltpetre at Paris.

Where is it found?

Iodine is frequently met in nature among fuci, which grow on the sea-shore; in sponges, and in various salt springs. It is also found in the mineral kingdom in combination with silver.

Of what color is iodine?

Iodine is of a bluish black color, and has a metallic lustre; it is very volatile, rising in a rich violet colored vapor at a temperature of between 80° and 100° F.

What are some of the properties of iodine?

Iodine is a non-conductor of electricity, has an acrid taste, and is sparingly soluble in water.

Can phosphorus be fired by iodine?

Phosphorus may be fired by dropping upon it a few scales of iodine.

What is a delicate test for the presence of iodine?

Starch is a delicate test, being changed by it to a beautiful blue color.

Has iodine ever been used as a medicine?

Iodine is used as a medicine with much success in various diseases.

Does iodine change vegetable colors?

Iodine destroys vegetable colors, but less powerfully than chlorine.

BROMINE.

By whom was bromine discovered?

Bromine was discovered by M. Balard, of Montpelier, in the year 1826. It was described by him under the name of muride, because obtained from the sea. It has since been changed to bromine, from the Greek *bromos*, in allusion to its strong odor.

Where is it found?

It is found in sea waters, and is a brilliant red-colored liquid : it is used but very little in the arts. Bromine is exceedingly volatile, and, when exposed to the air, passes off as a gas, which is extremely poisonous.

Is bromine noxious?

Bromine is very noxious when inhaled, and very poisonous when swallowed.

Does bromine possess bleaching properties?

Bromine possesses bleaching properties,

acts powerfully on animal and vegetable bodies, and corrodes the skin.

Is bromine a supporter of combustion?

Bromine is a supporter of combustion: antimony and tin take fire, and potassium, when brought into contact with bromine.

What is a test of bromine?

Bromine is easily detected by means of chlorine.

FLUORINE.

In what state does fluorine exist?

Fluorine exists in a state of combination with lime. It appears to belong to the class of negative electives, and, like oxygen and chlorine, to have a powerful affinity for hydrogen and metallic substances.

Of what is fluorine one of the constituents?

Fluorine is one of the constituents of fluor spar, from which mineral the compounds of fluorine are obtained.

How is hydrofluoric acid obtained?

Hydrofluoric acid is obtained by heating a mixture of sulphuric acid and powdered fluor spar.

SELENIUM.

When and by whom was this substance first discovered?

This substance was first discovered by

Berzelius in 1818, who gave it its present name, from the moon.

Where is it found?

Selenium is found among the volcanic products of the Lipari Islands, combined with lead, cobalt, silver, mercury and copper.

What are some of the properties of selenium?

It is a brittle, opaque solid, without taste or odor.

How is chloride of selenium obtained?

Chloride of selenium is obtained by placing selenium in chlorine gas.

How is bromide of selenium obtained?

Bromide of selenium is obtained by dropping selenium into bromine.

LECTURE XXXIX.

BORON; SILEX.

By whom was boron first obtained?

Boron was first obtained by Davy, 1807; its properties were first investigated by Gay-Lussac and Thénard.

Is borax ever found entirely pure in nature?

Borax is never found entirely pure in nature. It is found in the East Indies, and in the craters of volcanoes.

What are some of its properties?

It is a dark olive colored substance, which has neither taste nor smell: it is a nonconductor of electricity, insoluble in water, alcohol, ether and oils.

By whom is boron principally used?

Boron is principally used by blacksmiths in welding iron.

Boron united with oxygen, forms what?

Boron united with oxygen, forms boracic acid.

Where is this acid sometimes found?

Boracic acid is sometimes found in the hot springs of Lipari; it occurs under the form of borax, a native compound of boracic acid and soda.

How is it prepared for chemical purposes?

Boron is prepared for chemical purposes by adding sulphuric acid to a solution of purified borax, in about four times its weight of boiling water.

In what gas does boron burn?

Boron burns with great brilliancy in chlorine gas.

Is boracic acid ever used in commerce

This acid has become very common, and is sometimes used with soda in the manufacture of borax.

SILICON.

Is silex found entirely pure in nature?

Silex is found entirely pure in nature.

Of what color is pure silicon?

Pure silicon is of a dark brown color: it exhibits no metallic lustre, even by rubbing.

What are the properties of silicon?

Silicon is tasteless and destitute of odor: it is a bad conductor of heat and electricity; burns neither in the air nor in oxygen.

What is the oxide of silicon called?

The oxide of silicon is sometimes called silex, the latin name for flint.

Is silex a useful substance?

Silex is useful in manufacturing earthen ware, from the most common to the richest china.

In what is silex found?

Silex is found in rock crystal, flint, sand, and in many precious stones.

When deeply colored with iron, what does it become?

Silex, when deeply colored with iron, becomes amethyst.

Of what origin are agates?

Agates are of volcanic origin: they are silex, tinged with different degrees of iron.

Are all kinds of glass composed of silica?

All kinds of glass are composed of silica. Quartz is an element of glass, and is composed of silex and potash.

Of what is green glass made?

Green glass is made of impure materials, such as river sand, which contains iron, and the most common kind of pearlash. The green color is owing to the impurities in the ashes, but chiefly to oxide of iron.

What is crown glass used for?

The name crown is given to the best kind of window glass: it is made of purer alkali, and sand which is free from iron

Of what is plate glass composed?

Plate glass is composed of the purest material, and is used for looking-glasses.

Of what is flint glass made?

Flint glass consists of about three parts of fine sand, two of red lead and one of pearlash, with small quantities of nitre, arsenic and manganese.

How may agates, and many of the precious stones, be tested?

Agates, chalcedony and carnelian, may be tested with glass: if it will scratch them, they are not real.

LECTURE XL.

GENERAL PROPERTIES OF THE METALS.

Do metals constitute an important class of substances?

Metals are the most important of substances.

How many distinguishing properties have metals?

Metals have three distinguishing properties:

1. They conduct caloric and electricity;
2. They do not transmit light;
3. They have a metallic lustre.

Every substance in which these characters are found, may be regarded as a metal.

What is the number of metals at present known to chemists?

The number of metals at present known to chemists is 42.

Are there many that exist in a pure state?

There are about twenty-nine that can remain without being united to other substances.

Mention some of the most important.

The most important of metals are :

Iron,	Arsenic,	Silver,
Lead,	Manganese,	Mercury,
Copper,	Platinum,	Bismuth,
Zinc,	Gold,	Cobalt.
Antimony,		

Do they differ in their properties?

They differ in the following properties:

1. Specific gravity. Great specific gravity was formerly considered as a distinctive character of the metals: there was none known less than six times heavier than water, previous to the decomposition of the alkalies. Potassium and soda are so light that they float upon the surface.

Which is the heaviest of all known substances?

Platinum is the heaviest of all known substances.

What is the second property they differ in?

2. Malleability.

What is meant by malleability?

Malleability is a property which permits the metals to be extended under the hammer.

Which is the most malleable of all metals?

Gold surpasses all metals in malleability: one grain may be extended so as to cover

fifty-two square inches of surface. Iron is less malleable, and zinc still less.

What is the third property in which they differ?

3. Ductility.

When are metals said to be ductile?

Metals are said to be ductile, when they are capable of being drawn out into wire.

Which of the metals are the most ductile?

Gold, silver, platinum, iron and copper, are the most ductile.

Do the metals differ in hardness?

Metals differ considerably from each other in hardness.

Do they also differ in structure?

Many of the metals have a crystalline structure: some are fibrous, as zinc; others compact, as lead.

Do they also differ in their fusibility?

All metals are solid, at the common temperature of the atmosphere; but the point of fusion in the different metals varies exceedingly.

Are metals volatile?

Metals are volatile.

What is meant by the volatility of a metal?

By the volatility of a metal is meant the tendency which metals have to fly off, or

their being capable of conversion into vapor. Platinum has been reduced to vapor.

Are the metals considered as elementary or compound bodies?

The metals are generally considered as elementary bodies.

How are metals found in nature?

Metals are rarely found in their simple or pure state; but when they are thus found, they are said to be in a native state.

When found in combination with other bodies, especially with oxygen and sulphur, in what state are they said to be?

The metals are then said to be mineralized.

How are the metals generally found?

Metals, when generally found, are in the state of oxides, sulphurets and carbonates, and are called ores.

How are metals obtained from the ore?

The metals are obtained from the ores by various processes; such as sorting, stamping, washing, roasting, smelting and refining.

What art is the process of determining the purity of the metals sometimes termed?

The art of assaying.

What is the process of assaying?

The general process consists in selecting specimens, in equal portions, of those which appear to be the richest, the poorest, and

those of medium value, and reduce them to coarse powder: it is then washed, in order to carry off any earthy or stony matter. It is then roasted in a shallow earthen vessel under a muffle, to expel the volatile principles. The assaying of the precious metals is usually confined to ascertaining the quantity of gold or silver in any alloy or compound.

What is meant by an alloy?

The union of a metal with one or more metals, is termed an alloy.

Of what is brass an alloy?

Brass is an alloy of copper and zinc.

Of what is pewter an alloy?

Pewter is an alloy of tin with lead.

With what is gold commonly alloyed?

Gold is commonly alloyed with silver and copper.

With what is silver usually alloyed in commerce?

Silver is usually alloyed with a little copper, in order to increase its hardness.

Do the alloys resemble the metals in many of their physical properties?

The alloys resemble the metals in many of their physical properties:

1. They are opaque;

2. They are good conductors of electricity and caloric;

3. They possess a metallic lustre;

4. They are more or less crystalline in their structure.

Is the hardness of a metal increased by being alloyed?

The hardness of a metal is in general increased by being alloyed.

Is the fusibility of metals increased by being alloyed?

The fusibility of metals is greatly increased by being alloyed: thus pure platinum, which can not be completely fused in the most intense heat of a wind furnace, forms a very fusible alloy with arsenic.—BECK.

What is meant by amalgam?

The term amalgam is applied to compounds of mercury with the other metals.

Are amalgams solid or liquid?

Amalgams may be formed so as to be either solid or liquid.

How may a solid amalgam be formed?

Quicksilver unites with potassium when agitated in a glass tube with that metal, forming a solid amalgam.

What is an amalgam of tin and mercury used for?

An amalgam of tin and mercury is used for silvering mirrors.

LECTURE XLI.

CLASSIFICATION OF METALS.

How may the metals be divided?

The metals may be divided into two great classes.

CLASS I. Metals which, by oxidation, yield alkalies and earths.

CLASS II. Metals, the oxides of which are not alkalies or earths.

Into what is the first class of metals divided?

Class I is divided into three orders, viz:

ORDER 1. Metallic bases of the alkalies; these are three in number:

Potassium, Sodium, Lithium.

ORDER 2. Metallic bases of the alkaline earths, are four in number:

Barium, Strontium, Calcium, Magnesium.

ORDER 3. Metallic bases of the earths are five in number:

Aluminum, Yttrium, Zirconium, Glucinum, Thorium.

Into how many orders is the second class of metals divided?

Class II is divided into three orders.

ORDER 1. Metals which decompose water at red heat, are seven in number :

Manganese,	Cadmium,	Cobalt,
Iron,	Tin,	Nickel.
Zinc,		

ORDER 2. Metals which do not decompose water at any temperature, and the oxides of which are not reduced to the metallic state by the sole action of heat :

Arsenic,	Columbium,	Bismuth,
Chromium,	Antimony,	Titanium,
Vanadium,	Uranium,	Copper,
Molybdenum,	Cerium,	Lead.
Tungsten,		

ORDER 3. Metals, the oxides of which are decomposed by red heat, are eight in number :

Mercury,	Platinum,	Osmium,
Silver,	Palladium,	Iridium.
Gold,	Rhodium,	

METALS OF THE FIRST CLASS.

Metallic bases of the alkalies.

POTASSIUM.

When and by whom was potassium, or kalium, discovered?

Potassium or kalium was discovered by Davy in the year 1807.

By what process did he obtain the metal?

Sir H. Davy slightly moistened hydrate of potassa, then subjected it to the action of a powerful battery : the oxygen of both the water and potassa passed over to the positive pole; while the hydrogen of the former, and metallic potassium, appeared at the negative. By this process, however, the metal is obtained in small quantity only.

Who invented the method by which a larger supply may be obtained?

Gay-Lussac and Thénard invented a method by which a larger supply may be obtained. This process consists in bringing the fused hydrate of potassa into contact with turnings of iron, heated to whiteness in a gun barrel. The iron attracts the oxygen from the alkali, and its metallic base is disengaged.

Potassium may also be prepared, as first noticed by M. Curandau; by mixing dry carbonate of potassa with half its weight of powdered charcoal, and exposing the mixture contained in a gun barrel, or spheroidal iron bottle, to a strong heat.

What are some of the properties of potassium?

Potassium is a soft malleable solid, yielding to the pressure of the fingers, like wax; of a metallic lustre. similar to mercury in color.

But what is the most remarkable property?

The most remarkable property of potassium is its affinity for oxygen. It oxidizes rapidly in the air or oxygen gas; but if a piece be thrown upon water, it will decompose it rapidly, disengaging so much heat that the potassium takes fire and burns with a beautiful purple flame.

Has there been any experiment performed?

The following is an instructive experiment: Take a piece of potassium, wrap it up in a small piece of paper, and introduce it quickly into a glass test tube, inverted in a small vessel of infusion of blue cabbage, the tube being filled with the same liquid. The metal will immediately rise to the top, and the moment the water reaches it through the paper, part of it will be decomposed, the oxygen combining with it and forming potassa, which changes the blue of the infusion to a green; while an equivalent portion of hydrogen gas is found in the tube, and may be inflamed by a lighted taper. But, perhaps, the most striking illustration of the deoxidizing power of potassium is exhibited by its action on carbonic acid gas: it takes fire, and by uniting with its oxygen forms potassa, while the liberated carbon is deposited in the form of charcoal —Beck.

Does potassium inflame in chlorine gas?

Potassium inflames spontaneously in chlorine gas, and burns with great brilliancy, forming chloride of potassium.

Has potassium a strong affinity for chlorine?

Potassium has a stronger affinity for chlorine than for oxygen, as its oxides are decomposed by chlorine gas.

How is the potash of commerce obtained?

The potash of commerce is chiefly obtained by evaporating the ley of wood or vegetable ashes.

What forms the basis of most soaps?

Potassa forms the basis of most soaps.

SODIUM.

By whom was sodium discovered?

Sodium was discovered by Sir H. Davy, in the year 1807.

What are some of the properties of sodium?

Sodium is a solid, at ordinary temperatures; has the lustre and general appearance of silver. It possesses the property of welding; fuses at 200°, and rises in vapor at a full red heat. When exposed to the air, it soon tarnishes, though less rapidly than potassium.

What are some of the uses to which sodium is applied?

Sodium is employed in the manufacture of hard soaps, and for chemical and medical purposes.

How is the peroxide of sodium [illegible]

The peroxide of sodium is [illegible] heating sodium to a [illegible] of pure oxygen. It is a white [illegible] but no acid or alkali [illegible]

What is said of the [illegible]

"Soda or [illegible] is distinguished from the [illegible] the following [illegible] sulphuric acid [illegible] and form [illegible] salt [illegible] are soluble in water [illegible] ed by [illegible] salt [illegible] the [illegible] —[illegible]

[illegible]

The [illegible] is [illegible] is [illegible] is found [illegible] [illegible] [illegible] [illegible] [illegible]

What are some of the uses [illegible] sodium?

It is used for bleaching, and removing the odors which arise from drains, sewers, or all kind of animal matter in a state of putrefaction. It is employed in surgical practice, for destroying the fetor of malignant ulcers.

LITHIUM.

Is lithium a metal?

Lithium is a white-colored metal, like sodium.

By whom was it discovered?

Lithium was first obtained from lithia by Sir H. Davy, by means of galvanism; but it oxidized so rapidly, that he was unable to examine its properties.

How is lithia distinguished from potassa and soda?

Lithia is distinguished from potassa and soda, by its power of saturating a greater quantity of any acid. The chloride of lithium dissolves in alcohol, and the solution burns with a red flame. "The salts of lithia, when heated on platinum wire before the blowpipe, tinge the flame of a red color."—TURNER.

LECTURE XLII.

FIRST CLASS OF METALS.

Order 2 — Metals which, with oxygen, form alkaline earths.

BARIUM, STRONTIUM, CALCIUM AND MAGNESIUM.

By whom was barium discovered?

Barium was first obtained by Sir H. Davy.

What are some of the properties of barium?

Barium is of an iron gray color, with little lustre. It attracts oxygen from the atmosphere and from water, and crumbles into a white powder, which is the protoxide of barium.

How may the peroxide of barium be obtained?

The peroxide of barium may be obtained by heating baryta in oxygen gas.

What is the process by which barium is obtained?

The process consists in forming carbonate of baryta into a paste with water, and placing a globule of mercury into a little hollow made in its surface. The paste was laid upon a platinum tray which communi-

cated with the positive pole of a galvanic battery of 100 double plates, while the negative wire was brought into contact with the mercury. The baryta was decomposed, and its barium entered into combination with mercury. This amalgam was then heated in a vessel free from air, by which means the mercury was expelled, and barium obtained in a pure form.—TURNER.

STRONTIUM.

Of what is strontium the base?

Strontium is the metallic base of strontia, an alkaline earth, which so nearly resembles baryta, that it has frequently been considered the same substance; but the existence of strontia was established in the year 1792, by Dr. Hope, of Edinburgh. He extracted what he considered as a new earth, from the strontianites, a mineral found in the lead mine of Strontian, in Argyleshire, Scotland; and hence the origin of the term strontites or strontia, by which the earth itself is designated.

By whom was the base of strontia discovered?

The base of strontia was discovered by Sir H. Davy, by a process analogous to that described for procuring barium.

How may the hydrate of strontia be obtained?

How is this metal procured?

This metal was procured by the action of potassium on the chloride of thorium; decomposition being accompanied by a slight detonation. On washing the mass, thorium is left, in the form of a heavy metallic powder, of a deep leaden gray color; and when pressed in an agate mortar, it acquires metallic lustre, and an iron gray tint.—TURNER.

How is the carbonate of thorina formed?

The carbonate of thorina is formed by heating thorina with sugar.

ZIRCONIUM.

By whom was zirconium discovered?

Zirconium was discovered by Berzelius, in 1824.

What are some of the properties of zirconium?

The substance exists in a powder black as charcoal, which may be boiled in water, without being oxidized: it is a non-conductor of electricity, and takes fire when heated in the open air, at a temperature below a red heat.

Where are crystals of zirconia found?

Crystals of zirconia are now found in different parts of our own country: in Buncome county, N. C.; at Easton, Pa.; and in Monroe and Haddam in the State of Connecticut.

What is lime?

Lime is a brittle, white, earthy solid.

How is lime water prepared?

Lime water is prepared by mixing hydrate of lime with water, then agitating the mixture, and set it aside, in a bottle well corked, until the undissolved parts shall have subsided.

What are some of the uses of lime?

Lime is very extensively used in the preparation of mortar for building, for whitening walls, and as an antacid in medicine. It is found very abundantly in nature, constitutes a part of the teeth and bones of animals, enters in many vegetable combinations, and forms a large portion of the rocky strata of the earth.

Is lime found pure in nature?

Lime is not found pure in nature, but is obtained by calcination of carbonate of lime, which exists in various forms, as limestone, chalk, marble, &c.

How is lime obtained for purposes of commerce?

Lime is obtained sufficiently pure for purposes of commerce, by calcining the common limestone in limekilns.

How is the milk or cream of lime made?

The milk or cream of lime is made, by mixing with the hydrate a little water, so

as to give it a liquid form, of the consistence of thin paste.

MAGNESIUM.

By whom was magnesium discovered?

Magnesium was discovered and obtained in small quantities, by Sir H. Davy; but M. Bussy obtained it in greater abundance by the action of potassium on chloride of magnesium.

By what process was it obtained?

Five or six pieces of potassium, of the size of peas, were introduced into a glass tube, the sealed extremity of which was bent into the form of a retort, and upon the potassium were laid fragments of chloride of magnesium; the latter being then heated to near its point of fusion, a lamp was applied to the potassium, and its vapor transmitted through the mass of the heated chloride. Vivid incandescence immediately took place; and on putting the mass, after cooling, into water, the chloride of potassium, with undecomposed chloride of magnesium, was dissolved, and metallic magnesium subsided.—TURNER.

What are some of the properties of magnesium?

Magnesium is a white powder, having neither taste nor odor: it is frequently used in medicine.

What are some of the properties of iron?

Iron is malleable, ductile, and in a pure state is very fusible.

Can iron be acted on by a magnet?

Iron is strongly attracted by the magnet, and acquires itself the magnetic power when in the form of steel : it retains its magnetism.

Does iron unite with carbon?

Iron unites with carbon in several proportions, but the most important of these combinations are steel and plumbago.

What will be the result, if a drop of acid fall upon steel?

If a drop of acid fall upon steel, the carbon is attracted by it, and a black spot appears.

What is cast iron, and for what is it used?

Cast iron is a compound of carbon and iron; and it is very extensively used in the construction of machinery, in the making of stoves, hollow-ware, nails, &c.

From what is steel generally prepared?

Steel is generally prepared from malleable iron.

What are some of the uses of steel?

Many instruments are made of steel, such as forks, penknives, saws, axes, &c.

ZINC.

Has the existence of zinc long been known?

Zinc, as a metal was known from its ores, has recently been discovered in Europe.

By what other name has zinc been called?

Zinc has been called spelter; and it is obtained either from "calamine, the native carbonate of zinc, or from the native sulphuret, the zinc blende of mineralogists."

What are some of the uses of zinc?

Zinc is used extensively in the arts, for the construction of voltaic instruments, for covering buildings, for the manufacture of kitchen utensils, and water pipes.

CADMIUM.

From what did cadmium derive its name?

Cadmium derived its name, because it is nearly always found associated with zinc.

By whom was cadmium discovered?

Cadmium was discovered by Stromeyer, in the year 1818.

By what process did he discover it?

"The ore of cadmium is dissolved in hydrochloric or sulphuric acid in excess. The sulphuret of cadmium is precipitated by hydrosulphuric acid. Nitric acid decomposes this, and forms a nitrate, which is evaporated to dryness. To a solution of this in water, an excess of carbonate of ammonia is added, and the white carbonate of the oxide of cadmium is precipitated, which, when subjected to a red heat, yields

a pure oxide. The metallic cadmium is obtained from the oxide, by heating it with charcoal."—GRAY.

By whom was an elegant process for separating zinc from cadmium, proposed?

"A very elegant process for separating zinc from cadmium, was proposed by Dr. Wollaston. The solution of the mixed metal is put into a platinum capsule, and a piece of metallic zinc is placed in it. If cadmium is present, it is reduced, and adheres so tenaciously to the capsule, that it may be washed with water without danger of being lost. It may then be dissolved either by nitric or dilute muriatic acid."—TURNER.

TIN.

What is the history of tin?

Tin was known to the ancients, in the time of Moses, and was in common use by the Phœnicians. It is supposed that they obtained it from Cornwall, England.

Where is tin found?

Tin is found in India, Germany, Chili, and Mexico.

What are some of the properties of tin?

Tin is a white metal, harder than lead, and produces a crackling sound when bent. It is very malleable, and may be beaten in tinfoil leaves: its odor and taste are peculiar, but it tarnishes on exposure to the air.

What are tin plates?

Tin plates are sheets of iron coated with tin.

From what is tinfoil made?

Tinfoil is made from the finest tin beaten out with a hammer.

What are some of the uses of tin?

It is used extensively in the manufacture of culinary articles, and it is also used for roofing houses.

COBALT.

What is the origin of the name cobalt?

Cobalt derives its name from Cobalus, an evil spirit, who is supposed to visit mines, impede the operation of the miners, and destroy their lives.

When was cobalt discovered?

The metal cobalt was discovered in the fifteenth century.

What are some of the properties of cobalt?

Cobalt is a solid metal, hard, brittle, of a reddish gray color, and weak metallic lustre.

Where is cobalt found?

Cobalt is found in nature, in the form of oxide, of sulphate, of arseniate, and in combination with many combustibles, especially with sulphur and arsenic.

What is the zaffre of commerce?

The zaffre of commerce is an impure oxide of cobalt.

How may sympathetic ink be made?

Sympathetic ink may be made by dissolving the oxide of cobalt in muriatic acid, diluted with water. Words written with this solution, will be invisible, till brought in contact with the fire, when the writing will appear of a bright green tint.

What is one of the most important properties of cobalt?

One of the most important properties of cobalt, is that it is highly magnetic.

NICKEL.

When was nickel discovered?

Nickel was discovered by Cronstedt, in 1751 : the term nickel was applied to the ore, because it looked like copper, but did not yield it.

What are some of the properties of nickel?

Nickel has a strong metallic lustre, ductile and malleable; attracted by the magnet, and, like iron and cobalt, may be rendered permanently magnetic : when pure, its color is white, but the nickel of commerce is usually of a reddish color.

Does nickel form an alloy with any of the metals?

Nickel may be alloyed with most of the metals. An alloy of iron and nickel has been found in all the meteoric stones that have been analyzed.

LECTURE XLV.

SECOND CLASS OF METALS.

Order 2 — Metals which do not decompose water at any temperature, and the oxides of which are not reduced to the metallic state by the sole action of heat.

ARSENIC.

By whom was arsenic discovered?

Arsenic was first discovered by Dioscorides, who called it sandarac.

Where is arsenic found?

Arsenic is found in nature in small quantities.

What are some of its properties?

Arsenic is a very brittle metal, and of a crystalline structure: it burns with a blue flame and white smoke, giving off a strong odor of garlic, a property which belongs to no other metal, unless it be zinc. When heated in the air, it is converted into the white oxide of arsenic.

What are some of the uses of arsenic?

Arsenic is used in the manufacture of glass, shot, &c.

What is the action of arsenic on the animal economy?

Arsenic is well known as one of the most violent of poisons, and acts not only when taken in the stomach, but also when applied externally to a wound, or inspired as a vapor.

CHROMIUM.

By whom was chromium discovered?

Chromium was discovered by Vauquelin, a French chemist, in a beautiful red mineral, the native chromate of lead.

What are some of the properties of chromium?

Chromium is a metal of a white color with a shade of yellow, has a metallic lustre, is brittle and very fusible; it is not changed by air, but absorbs oxygen at a red heat.

How may metallic chromium be obtained?

Metallic chromium may be obtained by exposing its oxide, mixed with charcoal, to the most intense heat of a smith's forge.

Does chromium possess any coloring properties?

Many of the gems owe their beautiful tints to the metal chromium. Its acid gives the red color to the ruby; its oxide, the green color to the emerald.

In what is the chromate of iron found?

The chromate of iron is found in marble and serpentine. There are some fine specimens of chromate of iron found in the United States.

VANADIUM.

From whence did vanadium derive its name?

Vanadium was so called from Vanadis, the name of a Scandinavian divinity, and was discovered by Sefstrom in 1830.

What are some of the properties of vanadium?

This metal, when obtained by means of potassium, is a heavy black powder with very little lustre; but when prepared by the decomposition of the chloride, it has a white color resembling silver, of a strong metallic lustre, but it is extremely brittle. It is not oxidized by either air or water, is not acted on by boiling sulphuric, muriatic, or hydrofluoric acid; but it is attacked by the nitric and nitro-muriatic acids, and the solution has a fine dark color.

MOLYBDENUM.

From whence does this metal derive its name?

It derives its name from the Greek *molubdaina*, lead; this metal at first being confounded with blacklead, now known by the name of plumbago.

Has it ever been found pure in nature?

Molybdenum has not been found pure, in a native state; it is separated from its ore, the native sulphuret, with considerable difficulty.

What are some of the properties of molybdenum?

Molybdenum is a brittle metal, of a white color, and very infusible.

TUNGSTEN.

Where was this metal first discovered?

Tungsten was first discovered in Sweden. In the Swedish language its name signifies heavy stone, from the Swedish words *tung sten.*

How is tungsten obtained?

Tungsten is obtained by exposing a mixture of tungstic acid and charcoal to a strong heat.

COLUMBIUM.

When was columbium discovered?

Columbium was discovered in 1801, by Hatchett, who detected it in a black mineral belonging to the British Museum, supposed to have come from Massachusetts, and from this circumstance applied to it the name of columbium. About two years after the discovery of columbium, a Swedish chemist, named Ekeberg, extracted the same substance from the mineral named tantalite. In 1809, Dr. Wollaston proved that tantalite was identical with columbium.

ANTIMONY.

By whom was antimony discovered?

Antimony was discovered by Basil Valentine, in the fifteenth century.

From what did antimony derive its name?

Antimony derived its name from anti-

monk, from its having proved fatal to some monks to whom it had been administered as a medicine.

Where is antimony found?

Antimony is sometimes found native; but its only ore which is abundant, and from which the antimony of commerce is derived, is the sulphuret: it is tarnished, but not otherwise altered, by exposure to the air.

What are some of the uses of antimony?

Antimony is much used in type foundries to give hardness to lead, in the alloy called type metal.

Is it ever used for medicinal purposes?

Antimony is a highly valuable medicine, when used with proper discretion.

URANIUM.

When was uranium discovered?

Uranium was discovered by a German, named Klaproth, in 1789.

From what does it derive its name?

It derives its name from the new planet Uranus, the discovery of which took place the same year.

What are some of the properties of uranium?

This metal, as prepared by Arfwedson, by conducting hydrogen gas over protoxide of uranium heated in a glass tube, is crystal-

line, of a metallic lustre and reddish brown color : when exposed to the air at common temperatures, it does not change; but when heated in open vessels, absorbs oxygen, and is reconverted into the protoxide.

CERIUM.

By whom was cerium obtained?

Cerium was obtained by Hisinger and Berzelius, in a rare Swedish mineral called cerite.

Where is cerium found?

Cerium is found in the mineral called allanite, as an oxide, which is very difficult to be reduced to the metallic state.

LECTURE XLVI.

SECOND CLASS OF METALS.

Order 2 continued.

BISMUTH.

Where is bismuth found?

Bismuth is found in the earth, in the form of pure ore, of an oxide, a sulphuret and an arseniate.

Is bismuth ever found in crystals?

Native bismuth is sometimes found in crystals, octohedra or cubes.

What are some of the properties of bismuth?

Bismuth is a metal of a reddish white color, brittle, and not easily oxidized by the air.

Does bismuth enter into alloys with any other metal?

Bismuth enters into various alloys with most of the metals, one of which is the fusible metal, composed of eight parts of bismuth, five of tin, and three of lead.

TITANIUM.

When was titanium first recognized as a metal?

Titanium was first recognized as a new metal by Mr. Gregor, of Cornwall, in 1791; and its existence was afterward established by Klaproth, who gave it the name of titanium, after the Titans of ancient fable.

By whom was its properties discovered?

Its properties were determined by Wollaston, in 1822, who found it in a slag of an iron smelting furnace in South Wales.

In what state is native titanium found?

Native titanium occurs in cubic crystals, whose color and lustre are like burnished copper; and it is so exceedingly hard, that it will scratch rock crystal.

To what use has the oxide of titanium been applied?

LECTURE XLVII.

SECOND CLASS OF METALS.

Order 3 — Metals, the oxides of which are decomposed by red heat.

Has mercury been long known?

Mercury was well known to the ancients: it was named by the alchemists from the planet Mercury.

By what name is it commonly called?

The common name of mercury is quicksilver.

How is mercury found?

Mercury is found in combination with sulphur, forming cinnabar.

What are some of the properties of mercury?

Mercury is distinguished from all other metals by being fluid at the ordinary temperature, and on this account it is used in many philosophical and chemical instruments.

What are the alloys of mercury with other metals called?

Alloys of mercury with other metals, are called amalgams.

What are some of the uses of mercury?

Mercury is made use of in medicine, in

the laboratory, and in the arts; it is also useful for the construction of thermometers and barometers.

Is mercury much used in medicine?

Mercury is extensively used for medical purposes.

For what use is a solid amalgam of tin employed?

A solid amalgam of tin is employed in making looking-glasses.

With what metals does mercury readily amalgamate?

Mercury readily amalgamates with gold, silver, tin, lead and zinc.

What is the process by which looking-glasses are silvered?

"In the silvering of plain looking-glasses, a flat, horizontal slab of stone is used as a table. This is smoothly covered with paper, and a sheet of tinfoil, equal to the size of the glass, is extended over it. A quantity of mercury is then laid upon the tinfoil, and immediately spread over it with a roll of cloth, or a hare's foot. Afterwards, as much mercury as the surface will hold, is poured on. While this mercury is yet in a fluid state, the plate of glass is slid on at the edge of the table, so as to pass over the tinfoil, driving the superfluous mercury before it. In this way any bubbles of air, and particles of dust, are prevented from

getting between the glass and the metal, and an uninterrupted coating is formed. In order to force out the remaining liquid mercury, the glass is placed in a sloping position, to allow the mercury to drain off; after which heavy weights are placed upon the glass, and suffered to remain for some time. The portion which is left, amalgamates with the tin, and forms a permanent reflecting surface, the smoothness and perfection of which depends upon the degree of regularity and polish which the glass possesses."—BIGELOW'S TECHNOLOGY.

SILVER.

By what name did the alchemists call this metal?

The alchemists called this metal Diana or Luna (the moon), probably on account of its white lustre.

What are gold and silver called?

Silver and gold are called the precious metals.

What are some of the properties of silver?

Silver is of a brilliant white color: it is malleable, and so ductile, that it is capable of being drawn into very fine wire. It is oxidated by the air: it is very soft when pure, so that it may be cut.

How is silver found?

Silver is frequently found pure in a native

state, though often sulphuretted, and alloyed with other metals, such as gold, antimony, copper and arsenic.

How is silver extracted from the ore?

Silver is extracted from the ores by two distinct processes, viz. cupellation and amalgamation.

What are some of the uses of silver?

Silver is used for many important purposes: for coining, and for many ornaments of utility.

Is silver capable of forming any alloys?

Silver forms an alloy with most other metals: an alloy of silver and brass is used as a solder for silver.

GOLD.

What is the history of gold?

Gold appears to have been known from the earliest ages of antiquity. It has hitherto been found in the metallic state.

Where is it found?

Gold is found in almost every country; but the most extensive mines are those of South America, Mexico, Peru and Hungary. It is also found in the United States, particularly in North Carolina, Virginia and Georgia. It is sometimes found in primary mountains, but more frequently in alluvial depositions, especially among sand in the beds of rivers, having been washed by water

out of disintegrated rocks in which it originally existed. It occurs massive, capillary, in grains, and crystallized in cubes and octahedrons.

What are some of the properties of gold?

Gold is a metal of a yellow color: it is capable of receiving a high lustre by polishing, but is inferior in brilliancy to steel, silver and mercury; but it is the most ductile of all metals.

What are some of the uses of gold?

Gold is employed for coin, and in the manufacture of a great many articles, which are chiefly ornamental. In the United States, both gold and silver coin are melted down for use in the arts, but in many countries it is forbidden by law.

Does the air change the color of gold?

Gold may be exposed for ages to the air and moisture, without being oxidized.

Will gold combine with iodine?

Gold will combine with iodine, bromine, sulphur and phosphorus.

Does gold form an alloy with any of the metals?

Gold forms an alloy with many of the metals.

What does it become when united with iron?

Gold, when united with iron, becomes magnetic.

Does mercury unite with gold?

Mercury readily unites with gold, and a gold ring will become white by mere contact with mercury.

How is the fineness or purity of gold expressed?

The fineness or purity of the gold is expressed by numbering the parts of gold which it contains. It is supposed to consist of 24 carats fine, when perfectly pure or unalloyed.

What is the standard gold coin of the United States and Great Britain?

The standard gold coin of the United States and Great Britain, is 22 carats fine.

How is water gilding prepared?

Mercury and gold combine, and form an amalgam which is employed in gilding. It is applied to the surface of silver, and the mercury driven off by heat.

PLATINUM.

When was this metal discovered?

Platinum was first discovered by the Spaniards, near the river La Plate, in South America. The word plata means silver.

What are some of the properties of platinum?

Platinum is the heaviest of all known substances: it is malleable, ductile and easily welded. Leaves of platinum are

used for wrapping substances that are to be exposed to great heat.

Palladium, rhodium, osmium and Iridium are found associated with platinum.

Will platinum combine with any of the metals?

Platinum combines with other metals, and forms alloys.

How is its affinity for lead shown?

"If a piece of lead foil, and another of platinum foil, of equal dimensions, be rolled up together, and the flame of a candle be cautiously directed by a blowpipe toward the edge of the rolls, at about a red heat, the two metals will combine with a sort of explosive force, scattering their melted particles, and emitting light and heat in a surprising manner."

PALLADIUM.

When and by whom was palladium discovered?

Palladium was discovered by Wollaston in 1803, and resembles platinum in color and lustre: it is both malleable and ductile.

From what did palladium derive its name?

Palladium was named after the planet Pallas.

RHODIUM.

By whom was rhodium discovered?

Rhodium was discovered by Wollaston.

What are some of the properties of rhodium?

Rhodium is of a white color, hard and extremely brittle.

OSMIUM.

By whom was osmium discovered?

Osmium was discovered by Tennant in 1803. It is a black powder, which acquires metallic lustre by friction.

What does osmium heated with chlorine form?

Osmium heated with chlorine, forms a chloride, of a beautiful color.

IRIDIUM.

By whom was iridium discovered?

Iridium was discovered by Tennant in 1803, and about the same time by Descotils of France.

LECTURE XLVIII.

SALTS.

Into how many orders are the salts divided?

The salts are divided by some chemists into four orders.

Sulphate of potassa was formerly called sal de duobus.

What are some of the properties of the sulphate of potassa?

It is white, and tastes saline and bitter, crystallizes in short six-sided prisms bounded by six-sided pyramids.

Is it ever found native?

This salt is found native, though not abundantly.

Can this salt be prepared artificially?

This salt can be prepared artificially by saturating carbonate of potassa with sulphuric acid; and it is procured abundantly as a product of the operation for preparing nitric acid.

How is bisulphate of potassa formed?

Bisulphate of potassa is formed by exposing the neutral sulphate, with half its weight of strong sulphuric acid, to a heat just below redness, in a platinum crucible, until acid fumes cease to escape.

What are some of its properties?

It has a sour taste, and reddens litmus paper: it is used for cleaning coin.

By what name is the sulphate of soda known?

The sulphate of soda is commonly known by the name of glauber salts.

Where is it found?

It is frequently found on the surface of the earth, and in mineral springs.

What are some of its properties?

It tastes bitter, cooling and saline: it crystallizes in four and six-sided prismatic crystals, but its primary form is an octahedron; effloresces on exposure to the air, and undergoes watery fusion when heated.

What are some of the uses of sulphate of soda?

Sulphate of soda is used in pharmacy, and in the manufacture of glass: it is sometimes decomposed for the purpose of obtaining soda, by igniting it with chalk and charcoal, or with iron and charcoal.

Sulphate of baryta is frequently known by what name?

Sulphate of baryta is frequently called heavy spar.

Is it ever found in a native state?

Sulphate of baryta is a common and abundant native product.

Where is it found?

It is found in the mines of Cumberland, Westmoreland, Transylvania, Hungary, Saxony and Hanover.

Is it ever found in the United States?

It is found in Missouri and Illinois.

Is it an insoluble salt?

It is one of the most insoluble salts.

By whom has it been used?

Painters use it as a substitute for white-lead.

What are the properties of the sulphate of strontia?

The sulphate of strontia has a blue tint, and is called celestine; it is nearly insoluble, requiring 4000 parts of cold, 3840 of hot water to dissolve it.

Is it ever found in a native state?

It occurs native in beautiful crystals in Sicily, and also on Strontia Island in Lake Erie.

Is the sulphate of lime a natural production?

This salt occurs abundantly in nature. The mineral called anhydrite, is an anhydrous sulphate of lime; and all the varieties of gypsum are composed of the same salt, united with water.

What have the pure crystallized specimens of gypsum been called?

The pure crystallized specimens of gypsums have sometimes been called selenites.

What are some of the properties?

It is nearly tasteless, soluble in 500 parts of cold, and 450 of boiling water; it is generally found in spring and river waters and especially in those called hard.

For what is the sulphate of lime used?

This salt, under the name of plaster of Paris, is largely used in agriculture; it is

used for taking impressions, for stereotype plates, and for casts, busts, and a great variety of purposes in the arts.

Sulphate of magnesia is generally known by what name?

Sulphate of magnesia is generally known by the name of epsom salts, and is frequently contained in mineral springs, as at Epsom in England.

Is it ever found native?

It is found incrusting the damp walls of cellars and new buildings.

What are some of its properties?

Its taste is saline, bitter, and nauseous; its crystals are small, quadrangular prisms, slightly efflorescent in dry air.

How can it be distinguished from the sulphate of soda?

It may be distinguished from sulphate of soda by the form of its crystals.

Sulphates of iron are commonly denominated what?

Sulphate of the protoxide of iron is known by the name of green vitriol, or copperas.

What are some of its uses?

It is of great use in dyeing.

Sulphate of zinc is known by what name?

Sulphate of zinc is the white vitriol of commerce.

What are some of its properties?

It is of a white color, and tastes bitter: it crystallizes by spontaneous evaporation; the crystals dissolve in two parts and a half of cold, and are still more soluble in boiling water.

Is it ever found native?

This salt is found native in places where the sulphuret of zinc occurs.

Is it ever prepared artificially?

It is prepared artificially by the action of dilute sulphuric acid upon metallic zinc, during the process for preparing hydrogen gas.

What are some of its uses?

It is used in medicine and the arts.

Sulphate of copper is commonly denominated what?

Sulphate of copper is commonly denominated blue vitriol, and roman vitriol.

What are some of its properties?

It slightly effloresces on exposure to the air; its crystals are of a blue color, the primary form of which is the rhomboidal prism.

DOUBLE SULPHATES.

What is the sulphate of soda and lime?

The sulphate of soda and lime is the glauberite of mineralogists.

Sulphate of potassa and alumina is known by what name?

Sulphate of potassa and alumina is called alum.

What are some of its properties?

Alum has a sweetish astringent taste, and reddens litmus paper; it crystallizes readily in octahedrons, or in segments.

What are some of its uses?

Alum is of great use in medicine and in the arts, especially in dyeing and calico printing.

What does iron alum resemble?

Iron alum very much resembles common alum, with this exception, that it frequently has a pink tint.

What is said of the crystals of chromium alum?

The crystals are black by reflected, but red by transmitted light.

How is manganese alum formed?

Manganese alum is formed by the replacement of alumina in common alum, by the sesquioxide of manganese.

LECTURE L.

NITRATES.

How may nitrates be prepared?

The nitrates may be prepared by the ac-

tion of nitric acid on metals, on the salifiable bases, or on carbonates. As nitric acid forms soluble salts with all alkaline bases, the acids of the nitrates can not be precipitated by any reagent.—T

How are the nitrates decomposed?

The nitrates are decomposed by the agency of heat.

What is the process of oxidation by nitre called?

The process of oxidation by nitre is called deflagration.

Nitrate of potassa is commonly called what?

The nitrate of potassa is generally known by the name of nitre or saltpetre.

Is it ever found native?

This salt is generated spontaneously in the soil; it crystallizes upon its surface, in several parts of the world, especially in the East Indies, whence the greater part of the nitre used in Britain is derived. It is found in several caverns of the United States.

What are some of its properties?

It is colorless, has a saline and cooling taste, and crystallizes readily in six-sided prisms.

In what is nitre frequently employed?

Nitre is sometimes employed as an oxidizing agent in the formation of nitric acid.

What are some of its uses?

In the East Indies, it is employed for cooling mixtures; in the arts, it is used extensively in making gunpowder, and it is also used in agriculture as a manure.

Of what is gunpowder composed?

Gunpowder is a solid explosive mixture composed of nitre, sulphur, and charcoal, reduced to powder, and mixed intimately with each other.

Are there any other uses to which nitre is applied?

It is used very much in the preservation of meat.

Has nitre ever been mistaken for sulphate of soda?

Nitre has sometimes been mistaken for sulphate of soda, and has thus been the source of fatal accidents.

How may it be distinguished from the sulphate of soda?

Nitre may be distinguished from the sulphate of soda, by its deflagrating when thrown upon burning charcoal.

Does nitre ever detonate?

Nitre does not detonate, except when in contact with inflammable matter.

Nitrate of soda has been called what, by old writers?

Nitrate of soda has been denominated cubic nitre.

Where is it found?

It occurs in the soils of India, and in Peru.

What are some of its properties?

It crystallizes in rhombs, and is somewhat deliquescent.

What are some of its uses?

It is used in the preparation of fireworks.

For what is nitrate of baryta used?

This salt is sometimes used as a reagent, and for preparing pure baryta.

What are some of its properties?

It crystallizes in transparent octahedrons, and is very apt to decrepitate by heat, unless previously reduced to powder.

How is nitrate of ammonia formed?

Nitrate of ammonia is formed by neutralizing dilute nitric acid by carbonate of ammonia, and evaporating the solution.

How is the nitrate of strontia formed?

The nitrate of strontia is prepared from the carbonate of strontia.

What are some of its properties?

It crystallizes in anhydrous octahedrons: they undergo no change in a moderately dry atmosphere, and are insoluble in alcohol.

What is it used for?

It is used for the red fire employed at theatres.

Where is the nitrate of lime found?

The nitrate of lime is found in old plaster and mortar.

Is nitrate of lime ever found native?

Nitrate of lime is found native in great abundance in caverns in Kentucky.

What are some of its properties?

It is very bitter and deliquescent, and is difficult to procure in regular crystals.

Is the nitrate of magnesia ever found native?

The nitrate of magnesia is frequently found in nature.

What are some of its properties?

It is very bitter, soluble in water, and crystallizes in prisms.

How is the nitrate of protoxide of copper formed?

Nitrate of protoxide of copper is formed by the action of nitric acid on copper.

What are some of its properties?

It crystallizes in prisms of a deep blue color: when heated to redness, it yields pure oxide of copper.

How is the nitrate of protoxide of lead formed?

The nitrate of protoxide of lead may be formed by digesting litharge in dilute nitric acid.

What are some of its properties?

It crystallizes in octahedrons, and has an acid reaction.

What is the nitrate of silver used for.

Nitrate of silver is the principal ingredient in indelible ink.

What are some of its properties?

It is colorless and transparent; is often adulterated with nitre, which is melted in it.

LECTURE LI.

CHLORATES.

Are any of the chlorates found native?

None of the chlorates are found native.

How can the chlorate of potassa be formed?

The chlorate of potassa may be formed by transmitting chlorine gas through a concentrated solution of pure potassa, until the alkali is completely neutralized.

What are some of its uses?

This salt has been much used in the manufacture of lucifer matches, and in the preparation of percussion powder.

How is the chlorate of baryta prepared?

The chlorate of baryta is prepared by digesting for a few minutes a concentrated

solution of chlorate of potassa, with a slight excess of silicated hydrofluoric acid; the alkali is precipitated in the form of an insoluble double hydrofluate of silica and potassa, while chloric acid remains in the solution. The liquid, after filtration, is neutralized by carbonate of baryta, which throws down the excess of silicated hydrofluoric acid, and chlorate of baryta remains in solution.—GRAY.

HYPOCHLORITES.

How are the hypochlorites produced?

The hypochlorites are produced by the action of chlorine gas on the salifiable bases.

Which is the most important of the hypochlorites?

The hypochlorite of lime is the most important.

What are some of its uses?

It is used principally for commercial purposes.

PHOSPHATES.

How many acids are isomeric?

There are three acids of phosphorus which are isomeric; the phosphoric, pyrophosphoric, and metaphosphoric.

What does arsenic acid resemble?

Arsenic acid resembles phosphoric acid in many of its properties.

Name some of the arsenites?

The arsenites of potassa, soda, and ammonia, may be prepared by acting with those alkalies on arsenious acid.

Are they soluble in water?

They are very soluble in water.

CHROMATES.

How may the chromates be distinguished?

The chromates may generally be known by their yellow or red color.

Can they be decomposed by heat?

They can.

How is the chromate of potassa formed?

The chromate of potassa can be prepared by heating to redness chromate of iron, with nitrate of potassa.

What are some of its properties?

It has a cool, bitter and disagreeable taste.

For what is the bichromate of potassa used?

The bichromate of potassa is of great use in dyeing.

What are some of its properties?

When slowly formed, it is deposited in crystals of a rich red color.

Of what does the chromate of lead consist?

Chrome yellow is a chromate of lead.

How is it formed?

It is formed by adding chromate of potassa in solution, to a solution of nitrate or acetate of lead.

BORATES.

How are the borates distinguished?

By digesting any borate in a slight excess of strong sulphuric acid, evaporating to dryness, and boiling the residue in strong alcohol, a solution is formed, which has the property of burning with a green flame.

What are some of the uses of borax?

It is used in forming colors. A very beautiful violet is made from a flux composed of borax and flint glass, colored with one-sixth part of the purple of cassius, precipitated from muriate of gold by protomuriate of tin.

Can any other colors be formed?

A fine red is made from red oxide of iron, prepared by nitric acid and heat, mixed with a flux of borax and a small proportion of red lead.

CARBONATES.

Are any of the carbonates found native?

Several of the carbonates occur native, such as the carbonate of soda, baryta, strontia, lime and magnesia.

How is the carbonate of potassa formed?

This salt is procured in an impure form

from the potash and pearlash of commerce.

How is the potash of commerce procured?

The potash of commerce is procured from the ashes of land plants by lixiviating them, and evaporating the solution to dryness.

What are some of its uses?

It is used in the manufacture of soap and glass.

Where is it manufactured?

It is manufactured in the United States, Canada and most parts of Europe.

How is pearlash formed?

The potash calcinated at a moderate heat, burns off the coloring particles, and the salt becomes of a spongy texture and of a beautiful bluish white tinge.

How is the bicarbonate of potassa made?

The bicarbonate of potassa is made by transmitting a current of carbonic acid gas through a solution of the carbonate of potassa.

What are some of its properties?

It crystallizes in eight-sided prisms, and is milder than the carbonate.

By whom is it used?

It is principally used by bakers.

How is the carbonate of soda obtained?

The carbonate of soda is obtained by lixiviating the ashes of sea-weeds, in the

same manner as the carbonate of potassa is obtained from the ashes of land plants.

By what name is it sometimes called?

It is frequently denominated sal soda, another variety is called kelp.

How is carbonate of ammonia obtained?

The only method of obtaining carbonate of ammonia, is by mixing dry carbonic acid with ammoniacal gas.

Where does the carbonate of baryta occur?

The carbonate of baryta occurs native in the mineral witherite.

From whence does the mineral derive its name?

The mineral derives its name from Dr. Withering, by whom it was discovered.

Is the carbonate of strontia ever found native?

The carbonate of strontia occurs native at Strontian, in Argyleshire.

By what name is it known?

It is known by the name of strontianite.

Is the carbonate of lime ever found native?

The carbonate of lime is a natural production and is found under a great variety of forms, such as limestone, marble, chalk, Iceland spar, &c.

Is carbonate of magnesia found native?

Carbonate of magnesia is found native in the mineral called magnesite.

What are some of its properties?

Its color is white, and dissolves very slowly in acid, unless it be reduced to powder.

Is the carbonate of protoxide of iron found in nature?

The carbonate of protoxide of iron is very abundant in nature, occurring sometimes in masses, and sometimes in crystals of a hexagonal form.

By what is the carbonate of protoxide of lead called?

White lead of painters.

LECTURE LII.

Order 2 — Hydro-salts.

What does the hydro-order of salts include?

The hydro-order of salts include those salts, the acid or base of which contain hydrogen.

What are the only salts included in this order?

The only salts included in this order, are formed by the hydracids with ammonia and phosphuretted hydrogen.

By what name is the hydrochlorate of ammonia called?

The hydrochlorate of ammonia is the sal ammoniac of commerce, and was formerly brought from Egypt.

From what does it derive its name?

It is said to receive the name, sal ammoniac, from being first obtained from the vicinity of the temple of Jupiter Ammon.

What are some of its properties?

This salt has a saline taste, is insoluble in water and alcohol.

What are some of the uses of hydrochlorate of ammonia?

Hydrochlorate of ammonia is used extensively in the arts, for a variety of purposes, it is also used in medicine.

Order 3 — Sulphur-salts.

What are sulphur salts?

The sulphur salts are double sulphurets, just as the oxysalts are double oxides.

How are the sulphur salts constituted?

The sulphur salts, with two metals, are so constituted that if the sulphur in each were replaced by an equivalent quantity of oxygen, it would form an oxysalt.

Into what are the sulphur salts divided?

The sulphur salts are divided into families, which contain the same sulphur acid.

How is the generic name formed?

The generic name of each family, is formed from the sulphur acid, terminated with sulphuret.

Is the class of sulphur salts extensive?

The class of sulphur salts are extensive, including several families of hydrosulphurets, carbo-sulphurets, &c.

Order 4 — Haloid salts.

Does the order of haloid salts include many families?

The order of haloid salts includes many families.

To what do the haloid acids belong?

The haloid acids belong generally to the electro-negative metals.

To what do the haloid bases belong?

The haloid bases belong to the electro-positive metals.

PART IV.

ORGANIC CHEMISTRY.

LECTURE LIII.

Of what does organic chemistry treat?

Organic chemistry treats of those compounds which are of animal or vegetable origin.

Of what does inorganic chemistry treat?

Inorganic chemistry comprehends all matter destitute of a living principle, such as fluids, gases, minerals.

In what does organic differ from inorganic substances?

Organic differ from inorganic substances in being composed of the same elementary principles, hydrogen, carbon and nitrogen.

What belongs to all organic bodies?

To all organic bodies belong a living principle.

Are they the subject of decay while the living principle is retained?

No, during life the elements of organic bodies are held together by vital affinity;

for it is life which gives the body the power of resisting the operation of decay.

What is the first natural division of organic bodies?

The first natural division of organic bodies is into animal and vegetable.

Is it difficult to determine wherein the difference consists?

Many philosophers have attempted to define wherein the difference consists, but have failed in the attempt. Some writers, among whom was the celebrated Buffon, have believed that there is in fact no exact boundary between the animal and vegetable kingdoms.

Can organic substances be formed artificially?

Organic substances can not be formed by the direct union of their elements.

How can they be obtained?

They can be obtained only as existing in organic bodies.

What is the agent by which organic bodies are formed?

The agent is life by which organic bodies are formed.

Do we know anything of this vital principle?

This vital principle eludes the researches of man.

What do we know of it?

All that we know of it is in effects, enabling the organized body to resist putrefaction, and to a certain degree to maintain a temperature in whatever situation it may be placed.

What is the difference between a stone and a plant?

If you remove a stone from one place to another, it suffers no alteration; if you take up a plant it will wither and die.

Are any of the organic bodies acid?

Many of the organic bodies are distinctly acid.

Where are they found?

They are found among vegetable and animal products.

From what does malic acid derive its name?

Malic acid is so called, because it is obtained from the apple, malum.

From what does citric acid derive its name?

Citric acid is obtained from the lemon, citron.

From what is quinic acid obtained?

Quinic acid is obtained from the Peruvian bark (cinchonia).

Where is oxalic acid found?

Oxalic acid is found in several species of sorrel.

How is tartaric acid obtained?

Tartaric acid is obtained from the tamarind and the cranberries.

What is cream of tartar?

Tartaric acid, combined with potash, forms what is commonly called cream of tartar.

LECTURE LIV.

VEGETABLE CHEMISTRY.

Of what are vegetable substances composed?

Vegetable substances are composed of the three elementary principles, oxygen, hydrogen, and carbon.

Vegetable substances produce chemical combinations, and are distinguished by what name?

They are distinguished by the name of proximate, or ultimate principles.

What are proximate principles?

Proximate principles are such as are obtained from the plants, as sugar, starch and gum.

What are ultimate principles?

Ultimate principles are such as are obtained by the destruction of the compounds.

What constitutes proximate analysis?

The process by which vegetables are separated, constitutes proximate analysis.

What constitutes ultimate analysis?

Ultimate analysis consists in the reduction of proximate principles into their elements.

How was this formerly done?

This was formerly done by a process denominated destructive distillation.

What is called destructive distillation?

When the ultimate analysis is made by heating to redness in close vessels, the process is denominated destructive distillation.

VEGETABLE ACIDS.

What are vegetable acids?

Vegetable acids are that class of bodies which possess the properties of acids.

Are vegetable acids decomposed by red heat?

Vegetable acids are decomposed by red heat.

Are vegetable acids the products of nature alone?

Some of the vegetable acids are the products of nature alone, others are the products of both nature and art.

By whom was oxalic acid discovered?

Oxalic acid was discovered by Scheele.

Where is it found?

It is found in several species of sorrel, and belongs to the genus oxalis and rumex; and it also occurs in combination with lime or potassa.

Can oxalic acid be made artificially?

Oxalic acid may be prepared artificially, by the action of nitric acid upon various vegetable and animal substances.

What are some of the properties of oxalic acid?

Oxalic acid crystallizes in slender, flattened four and six-sided prisms, with two-sided summits, the primary form of which is an oblique rhombic prism. It has a very sour taste, reddens litmus paper, and forms neutral salts with alkalies.

Is oxalic acid poisonous?

Oxalic acid is a very rapid and fatal poison.

Have accidents ever occurred in consequence of its resemblance to epsom salts?

Accidents have occurred frequently, in consequence of its resemblance to epsom salts.

How may these substances be distinguished?

These substances may be distinguished by the taste or by its reddening litmus paper.

When oxalic acid has been swallowed accidentally, what is the best remedy?

Take copious draughts of lime water: chalk or magnesia water, should be administered, and vomiting excited as soon as possible.

How is oxalic acid distinguished from all other acids?

Oxalic acid is distinguished from all other acids by the form of its crystals, and by its forming with lime water an insoluble precipitate.

For what is oxalic acid employed as a test?

Oxalic acid is employed as a test for lime and oxalates of potassa.

Oxalic acid with potassa, forms how many compounds?

Oxalic acid with potassa forms three compounds.

What are some of its properties?

It crystallizes in oblique quadrangular prisms, which have a cooling, bitter taste.

What are some of its uses?

It is used for detecting lime.

In what is binoxalate contained?

Binoxalate is contained in sorrel.

What are some of the uses of the binoxalate?

The binoxalate is often sold under the

How may the sublimation of benzoic acid be shown?

Suspend a small branch of a rosebush in a tall glass, without a bottom; place a small quantity of the acid upon a plate of metal; place the jar over the plate; at the same time, apply the heat of a lamp to evaporate the acid: the branch will be covered with delicate crystals.

How is camphoric acid obtained?

Camphoric acid is obtained from camphor by distillation with nitric acid.

What are some of its properties?

Camphoric acid has a somewhat bitter and sour taste, an aromatic odor, reddens litmus, and is sparingly soluble in cold water.

Where is prussic acid obtained?

Prussic acid is obtained from peach meats and blossoms, from bitter almonds, &c.

What are some of the properties of prussic acid?

Prussic acid is a limpid colorless liquid, and gives out a strong odor similar to that of peach blossoms.

Is prussic acid ever poisonous?

Prussic acid is a powerful poison, producing insensibility and convulsions, which are soon followed by death. A single drop placed upon the tongue of a dog causes death in a very few seconds.

How are the effects of prussic acid counteracted?

The poisonous effects of prussic acid are best counteracted by the solution of ammonia.

What are some of the uses of prussic acid?

Prussic acid, in a very dilute state, is used in medicine.

When is cinnamic acid formed?

Cinnamic acid is formed when oil of cinnamon is long exposed to the action of the atmosphere.

Where is meconic acid found?

Meconic acid is found in opium, combined with morphine.

What are some of the properties of meconic acid?

Meconic acid is very sour, reddens litmus, and is soluble in water and alcohol.

How is stearic acid obtained?

Stearic acid is obtained from soap.

What are some of the properties of stearic acid?

Stearic acid is tasteless, insoluble in water, and burns like wax.

From what is oleic acid obtained?

Oleic acid is obtained from the soap made from linseed oil and potassa.

What are some of the properties of oleic acid?

Oleic acid has a little taste, and burns like the fixed oils.

From what is margaric acid obtained?

Margaric acid is obtained from the various oils and fats.

Are there any other vegetable acids?

There are many other vegetable acids, but we have noticed some of the most important.

LECTURE LVIII.

VEGETABLE ALKALIES.

What do vegetable alkalies comprehend?

Vegetable alkalies comprehend those proximate principles which exist naturally in plants, and possess alkaline properties.

When was the existence of the vegetable alkalies discovered?

Their existence was discovered in 1805, but excited no attention until about 1816.

How are they distinguished from most vegetable substances?

They are distinguished from most substances of vegetable origin, by containing nitrogen.

Are these substances ever found in a free state in plants?

These substances are never found in a free state in plants, but appear to be combined with an acid, with which they form salts more or less soluble in water.

For what is the vegetable alkali, termed morphia, used?

Morphia is the native principle of opium, in which it is combined with various other principles.

What are some of its properties?

Morphia readily crystallizes from its alcoholic solution in small right rhombic prisms.

How are the salts of morphia prepared?

The salts of morphia are prepared by dissolving it in dilute acids, and evaporating the solution.

Are the salts of morphia poisonous?

The salts of morphia are a very powerful poison: one half a grain in solution will produce an alarming effect on the animal system.

Are the salts of morphia ever used in medicine?

Some of the salts of morphia are useful as medicine; of which, the hydrochlorate and acetate are the principal.

By whom was cinchonia and quinia found?

Cinchonia and quinia were detected by Pelletier and Caventou in 1820. Cinchonia exists in the Cinchona condaminea, or pale bark: quinia, often with a little cinchonia is present in C. cordifolia, or yellow bark; and they are both contained in C. oblongifolia, or red bark.

What are some of the properties of cinchonia?

Cinchonia is insoluble in cold water, and nearly so in hot water; in boiling alcohol, it is freely dissolved.

Does quinia form salts?

Quinia forms several salts, one of which, the sulphate, is manufactured in large quantities for medical purposes.

By what name is it commonly called?

It is commonly called by the name of quinine: its use as a specific in intermitting fever is well known.

What are some of its properties?

It crystallizes in delicate white needles, having the appearance of amianthus; has a bitter taste, and is less soluble in water than sulphate of cinchonia.

Is it ever adulterated?

The sulphate of quinia, from its commercial value, is frequently adulterated.

By whom was the vegetable alkali strychnia discovered?

The vegetable alkali strychnia was discovered in 1818 by Pelletier and Caventou.

Where is this alkali found?

This alkali is found in the nux-vomica, and in the upas tree of the island of Java.

Is it ever poisonous?

It is one of the most violent vegetable poisons known: its action is always accompanied by symptoms of locked jaw.

By whom was sanguinaria discovered?

Sanguinaria was discovered by Mr. Dana.

Where is it found?

It is found in the blood-root (Sanguinaria canadensis).

Of what color are its salts?

The salts of sanguinaria are of a red color.

LECTURE LIX.

NEUTRAL PRINCIPLES.

Where is starch found?

Starch exists abundantly in the vegetable kingdom, and is obtained from farinaceous grains and roots.

What are some of the properties of starch?

Starch is a white substance, insipid, inodorous, and is insoluble in alcohol, ether and cold water.

What effect does boiling water have upon it?

Boiling water converts it into a jelly, which is used for stiffening linen, and in cotton factories in the process of dressing.

What is the best test of starch?

The best test of starch is iodine.

How is starch commonly made?

In Europe starch is commonly made from wheat, and in this country from potatoes.

What is the manner of preparing it from potatoes?

The potatoes are rasped or ground, by a machine, to a pulp. This pulp, when washed in water, yields a white powder, which on subsiding proves to be a pure starch.

Are there any substances known in commerce, which are merely varieties of starch?

There are several varieties, the Indian arrow root, which is prepared from the root of the (Maranta arundinacea), is a very pure starch. Sago, prepared from the pith of an East India palm tree, and tapioca and cassava, from the root of a plant, are nearly the same.

GUM.

Are there many varieties of gum?

There are many kinds of gum.

What are some of the properties of gum?

Gums have neither taste nor smell; they are generally colorless, transparent and insipid. The true gums are those which dissolve in water, either hot or cold, and form with it a thick mucilaginous solution.

What are the names of the principal gums?

The most important gums are the gum arabic, gum tragacanth, and gum senegal.

What is gum arabic?

Gum arabic is the most common variety, and is the concrete juice of several species

of the mimosa, or acacia, natives of Africa and Arabia.

What are some of the properties of gum arabic?

Gum arabic occurs in small, rounded, transparent grains, which are sometimes colorless, and at others yellow, red or brown.

Are gum arabic and gum senegal very different?

Gum senegal contains the same principles as gum arabic.

Does gum tragacanth differ essentially from the pure gums?

Gum tragacanth differs essentially from the pure gum: it is tougher than common gum, which is quite brittle.

What are some of the uses of gums?

Gum, in the state of mucilage, is employed to give firmness and lustre to linen. It is used by calico printers, to give their colors such a degree of consistency as will prevent them from running upon the cloth. It is made to form an ingredient in writing ink, &c.

SUGAR.

Are there many varieties of sugar?

There are several varieties of sugar, the chief of which are common or cane sugar, and grape sugar.

Is sugar a native production?

Sugar is an abundant vegetable product, existing in a great many ripe fruits, in the juice of the maple, in the beet root, &c.

How is sugar obtained from the cane?

Sugar is obtained from the cane by evaporating the juice by a moderate ebullition, until the syrup is sufficiently thick to crystallize on cooling. During this operation; lime water is added, partly for the purpose of neutralizing free acid, and partly to remove impurities which rise with the lime in a scum to the surface; it is then drawn off into shallow wooden coolers, where it becomes a soft solid. It is then put into barrels with holes in the bottom, through which molasses gradually runs out, leaving raw or brown sugar.

How is raw sugar purified?

Raw sugar is purified by boiling a solution of it with white of egg, or bullock's blood and lime water.

What is then done with it?

The clarified juice is then received into conical earthen vessels, the apex of which is undermost, in order that the fluid parts may collect there, and be afterward drawn off by the removal of the plug.

What is it then called?

It then receives the name of loaf or refined sugar.

What are some of the properties of pure sugar?

Pure sugar is solid, white, inodorous, and of a very agreeable taste. It is hard and brittle, and, when two pieces are rubbed together in the dark, phosphoreseence is observed.

How can it be obtained in crystals?

Pure sugar is obtained in crystals, by fixing threads in a syrup which evaporates gradually in a warm room, in this state, it is called rock candy.

What is said of grape sugar?

Grape sugar contains rather less carbon than common sugar, and is more generally diffused in nature. It gives to most fruits their sweet taste, and forms the solid part of honey.

Of what does honey consist?

Honey consists of two kinds of sugar, one of which, when separated, crystallizes, and the other is uncrystallizable. It also contains gum, and probably an acid: when diluted with water, honey undergoes the vinous fermentation.

What is manna?

Manna is the concrete juice of several species of ash.

How is gluten obtained?

Gluten is obtained from wheat flour, by washing out the starch and boiling the remainder in alcohol.

What are some of the properties of gluten?

Gluten has scarcely any taste, is insoluble in water, alcohol and ether: when kept warm and moist, it ferments.

What causes the rising of bread?

The rising of bread is caused by the fermentation of gluten.

LECTURE LX.

OILS.

By what are the oils characterized?

Oils are characterized by their peculiar unctuous feel, their inflammability, and by being insoluble in water.

How are the oils divided?

The oils are divided into the fixed and the volatile oils.

How are the fixed oils obtained?

The fixed oils are usually contained in the seeds of plants, as, for example, in the almond, linseed, rapeseed and poppy seed.

How is the olive oil procured?

The olive oil is extracted from the pulp which surrounds the stone. It is procured by bruising the seed, and subjecting the pulpy matter to pressure in hempen bags, a gentle heat being generally employed at the same time to render the oil more limpid.

What are some of the properties of the fixed oils?

The fixed oils are those which do not evaporate without decomposition, or chemical changes. They produce an unctuous stain, which is not discharged by heat.

Do the fixed oils unite with the alkalies?

The fixed oils unite with the alkalies and form soap.

Into how many kinds are the fixed oils divided?

The fixed oils are divided into two kinds, the drying oils and the fat oils.

Why is the oil denominated drying oil?

By heating the oil in open vessels, it acquires the property of drying rapidly; in which process much oxygen is absorbed, and carbonic acid and hydrogen given off.

For what are drying oils used?

Drying oils are used for paint, and, when mixed with lampblack, constitute printer's ink.

Do the drying oils absorb the oxygen rapidly?

Drying oils sometimes absorb oxygen so rapidly as to set fire to combustibles. Spontaneous combustion often occurs where cotton has been moistened with them.

How many varieties of soap are there in commerce?

There are three varieties of soap in commerce, hard white soap, hard yellow soap and soft soap.

How is hard white soap made?

Hard white soap is made from tallow and caustic soda, which are boiled together.

How is hard yellow soap made?

Hard yellow soap is made of soda, tallow, and some coarse oil and rosin.

How is soft soap made?

Soft soap is made by boiling together some fatty matter and impure caustic po-

tassa, prepared by lixiviating common wood ashes.

Upon what does the hardness of soap depend?

The hardness of soap depends chiefly upon the alkali used; soda forming hard soap, and potassa forming the soft.

What are some of the most important of the fixed oils?

Linseed, oil of walnuts, oil of hempseed, castor oil, olive oil, and croton oil.

From what is linseed oil obtained?

Linseed oil is obtained from the seeds of common flax.

From what is the oil of walnuts obtained?

The oil of walnuts is procured from the common walnut.

From what is the oil of hempseed procured?

The oil of hempseed is procured from the common hemp. These three oils are distinguished for their drying properties, and are much used by painters.

Which of these oils have been found useful in burns?

Linseed oil and lime water has been found an excellent antidote for burns.

How is castor oil obtained?

Castor oil is procured from the seeds of the Ricinus communis. Its use in medicine is well known.

How is olive oil procured?

Olive oil is prepared from the common olive, the fruit of the Olea europea.

How is croton oil obtained?

Croton oil is obtained from the fruit of the Croton tiglium of the East Indies, and possesses powerful purgative properties.

What are the volatile or essential oils?

The volatile oils are those which evaporate, or may be distilled, without change, by a moderate heat.

To what do aromatic plants owe their odor?

Aromatic plants owe their peculiar flavor and odor to the presence of these oils, which are obtained from their different parts, as the flowers, leaves, stem, bark, or roots, by careful distillation; water being put into the still along with the plants, in order to prevent them from burning.

What are some of the most interesting of the essential oils?

Some of the most interesting of the essential oils are those of turpentine, caraway, cloves, peppermint, nutmeg, lavender, cinnamon, citron and chamomile.

Which is the most important of them all?

The oil of turpentine is the most important, and it is procured by distillation from common turpentine, a substance which exudes from incisions made in the wood of several species of the genus Pinus.

What are some of the uses of turpentine?

Turpentine is employed in the preparation of varnishes, and for some medical and chemical purposes.

How is the oil of bitter almonds obtained?

The oil of bitter almonds is prepared by distilling with water the bruised almonds.

What is camphor?

Camphor is a volatile oil, solid at common temperatures.

How is it procured?

It is obtained from the trunk and branches of the Laurus camphora of Japan, by distillation.

What are some of the properties of camphor?

Camphor is a solid white substance, has a pungent odor, and bitter aromatic taste: it is insoluble in water, but dissolves freely in alcohol, forming the common tincture of camphor.

LECTURE LXI.

RESINOUS SUBSTANCES.

What are resins?

Resins are the inspissated juices of plants, and commonly occur either pure or in combination with an essential oil.

What are some of the properties of resins?

Resins are solid at common temperatures, brittle, inodorous, and insipid; are non-conductors of electricity, and, when rubbed,

become negatively electric; they are generally of a yellow color, and semi-transparent. They are soluble in alcohol, ether, and the essential oils.

What are some of the uses of resins?

Various resinous substances are employed in the arts. Melted with wax and oil, resins constitute ointment and plasters. Combined with oil or alcohol, they form different kinds of oil and spirit varnish.

Of what is sealing wax made?

Sealing wax is composed of lac, venice turpentine, and common rosin. The composition is colored black by means of lampblack, or red by cinnabar or red lead.

Of what is lampblack composed?

Lampblack is the soot procured from the combustion of resinous wood, turpentine or resin.

Name some of the most important resins.

The most important are the common resin or rosin, copal, lac, sandarach, mastic, elemi, and dragon's blood.

When turpentine is extracted from the wood of the fir tree by heat, what is the product?

The product is what is commonly denominated tar.

What constitutes pitch?

Pitch is tar, inspissated by boiling or burning.

If turpentine be distilled, what is the product?

When turpentine is distilled, the volatile portion which passes over is the oil or spirit of turpentine.

What is amber?

Amber is a fossil substance, consisting of a peculiar bituminous matter and resin.

Where is amber found?

Amber is undoubtedly of vegetable origin, and is found abundantly on the southern coast of the Baltic sea, and to some extent on the Yorkshire coast, England, and in some parts of the United States.

What are balsams?

Balsams are the juices of some kinds of trees: they are compounds of resins and benzoic acid.

What are gum-resins?

Gum-resins are the concrete juices of certain plants, and consist of resin, essential oil, gum, and extractive vegetable matter. The two former principles are soluble in alcohol, and the two latter in water.

Are the gum-resins numerous?

The gum-resins are numerous, and many of them are valuable medicines; among them are aloes, asafœtida, galbanum, gamboge, myrrh and guaiacum.

By what name is caoutchouc commonly called?

Caoutchouc, or india rubber, is obtained from four species of trees, two of which grow in South America, and two in the East Indies.

LECTURE LXII.

BITUMINOUS SUBSTANCES.

What is naphtha?

Naphtha is a liquid, which exudes from the earth in some parts of Italy, and in Persia.

What are some of the properties of naphtha?

Naphtha has a strong, peculiar odor; it is generally of a yellowish color, but may be rendered perfectly limpid by distillation.

Where is petroleum found?

Petroleum is found in several parts of the world. It occurs particularly in coal districts.

What are some of the properties of petroleum?

Petroleum is of a reddish brown color, unctuous to the touch, and less limpid than naphtha.

Where is asphaltum found?

Asphaltum is found on the banks of the Dead Sea, and occurs in large quantity in Barbadoes and Trinidad.

What are some of the properties of asphaltum?

Asphaltum is a solid, brittle bitumen, of a black color, vitreous lustre, and conchoidal fracture. It melts easily, is very inflammable, and emits a bituminous

when rubbed, and by distillation yields a fluid like naphtha.

How is creosote obtained?

Creosote has been obtained from pyrolignous acid; but it is best prepared from those portions of the oil distilled from wood tar, which are heavier than water.

What are some of the properties of creosote?

Creosote is a colorless, transparent liquid of an oily consistence; has a burning taste followed by sweetness, and its odor is like that of wood smoke, or rather smoked meat. It is highly antiseptic to meat.

What are some of the uses of creosote?

Creosote is considerably used in medicine, both internally and externally. When placed upon the tongue, it occasions violent pain; and when poured in a concentrated state upon the skin, it destroys the epidermis.

How many kinds of mineral coal are there?

There are two varieties of mineral coal, bituminous coal, and stone coal, or anthracite.

How is bituminous coal distinguished?

Bituminous coal is distinguished by its softening like wax when thrown upon burning coals, and giving off much gas when heated, which of course burns with flame.

How does anthracite differ from the common coal?

Anthracite differs from common coal in

containing no bituminous substances, and in not yielding inflammable gases by distillation.

Where is anthracite found?

Anthracite is found in different countries, but is found most abundantly in the state of Pennsylvania, which supplies most of the northern and eastern parts of the United States.

Where is gas used extensively at the present day?

Gas is used extensively at the present day, for illuminating the streets of cities, and it appears to have been first introduced by Mr. Murdock, in 1792.

How is it prepared?

It is prepared by the distillalion of oleaginous and resinous substances, and bituminous coal.

How is coal gas prepared?

Coal gas is prepared by heating coal to redness in iron retorts. Gas formed from coal has always to be cleansed from hydrosulphuric acid, by passing it through milk of lime, before it is fit for use.

LECTURE LXIII.

COLORING MATTERS.

What are some of the most common colors in the vegetable kingdom?

The most common colors in the vegetable kingdom, are green, yellow, blue and red.

How have the coloring substances been divided?

The coloring substances have been divided into substantive and adjective colors.

What are substantive colors?

Substantive colors are those which communicate their tint immediately to the material to be dyed, without the intervention of a third body.

What are adjective colors?

Adjective colors require the intervention of a third substance, which possesses an attraction for both the cloth and the coloring matter.

What is the substance called which is thus capable of fixing the colors?

The substance which possesses the property of fixing colors, is denominated a mordant or basis.

Are the agents numerous which are capable of acting as mordants?

The mordants are numerous, but those which are principally employed in practice are the acetate of alumina, the sulphate or acetate of iron, and the muriate of tin.

Are the coloring substances used in dyeing numerous?

They are, but the most important of them are, indigo, madder, quercitron, &c.

What is the chief substance used for giving the blue dye?

Indigo is the chief substance used for giving the blue dye.

Where is indigo obtained, and how procured?

The best indigo is obtained from a plant cultivated in warm climates: it is cut a short time before it flowers, and put into large vats covered with water; fermentation then spontaneously ensues, during which the indigo subsides in the form of a pulverulent, pulpy matter. Its color is at first green, but by exposure to the air, it absorbs oxygen and becomes blue.

What are some of the properties of indigo?

Indigo is a light brittle substance, of a deep blue color; it is tasteless and destitute of odor; it is insoluble in water, and but slightly soluble in boiling alcohol; it is soluble in sulphuric acid.

What is the process of sublimation?

The process of subliming indigo is one of great delicacy, owing to the circumstance that the temperature at which it sublimes is very near that at which it is decomposed.

When cloth is dipped into a solution of deoxidized indigo, what color does it receive?

When cloth is dipped into a solution of deoxidized indigo, it becomes of a green color, which becomes blue by exposure to the air.

RED DYES.

What are the chief substances employed in giving red dyes ?

The chief substances employed in giving red dyes, are madder, cochineal, archil, brazil-wood, logwood and safflower, all of which are adjective colors.

What is madder?

Madder is one of the most valuable drugs in the art of dyeing; it is the root of the Rubia tinctorum, a plant extensively cultivated in Europe, and particularly in Holland. By the different use of mordants, it is made to produce every shade of red, purple, and even black.

Can calico printing be stamped with several mordants?

In calico printing,a piece may be stamped with several mordants, which are bases of different colors; and upon immersing it in a madder bath, as many colors will appear as there are mordants used.

How is cochineal obtained?

Cochineal is obtained from an insect, which feeds upon several varieties of cactus, and is supposed to derive this coloring matter from its food.

What are some of the properties of cochineal?

Cochineal is very soluble in water, and is fixed on cloth by means of alumina, or oxide of tin. Its natural color is crimson, but when bitartrate of potassa is added to the solution, it yields a rich scarlet dye.

Where is archil obtained?

Archil is obtained from a kind of lichen

(Lichen rocella), which grows chiefly in the Canary Islands, and is employed by the Dutch in forming the blue pigment called litmus.

What are some of the uses of litmus?

Litmus is used in dyeing, and is employed by chemists as a test for detecting the presence of a free acid.

What is logwood?

Logwood is a dense, heavy wood, and grows in the tropical parts of America.

What are some of its uses?

It is of very great use to dyers. The violet color of logwood is fixed by alum, and a blue is obtained from it by verdigris.

YELLOW DYES.

What are the chief yellow dyes?

The chief yellow dyes are the quercitron bark, turmeric, hickweld, fustic and saffron, all adjective colors.

BLACK DYES.

Of what are the black dyes made?

The black dye is made of the same ingredients as writing ink, and therefore consists essentially of a compound of oxide of iron with gallic acid and tannin. By the addition of logwood and acetate of copper, the black receives a shade of blue.

What are lakes?

Lakes are insoluble compounds of coloring matter with alumina, or oxide of iron or of tin.

LECTURE LXIV.

SPIRITUOUS AND ETHEREAL SUBSTANCES.

What is alcohol?

Alcohol is the product only of fermentation, and is never found ready formed in any vegetable substances.

How is alcohol obtained?

Alcohol is obtained by the distillation of ardent spirits.

What are some of the properties of alcohol?

Alcohol is a colorless fluid, of a penetrating odor, and burning taste: it is highly inflammable, and burns with a yellowish blue flame. No smoke is produced in its combustion, and hence it is of great utility for lamps in a laboratory.

What are some of its uses?

Alcohol is used in cabinets of natural history, for the preservation of specimens of fishes, reptiles, &c. As a solvent, alcohol is very useful. It is the intoxicating ingredient of every variety of spirituous and vinous liquors: taken internally, it operates, as is well known, as a powerful stimulant; and various alarming diseases, often terminating in extreme moral degradation and death, attend its habitual use.

ETHERS.

How are ethers formed?

Ether is the name applied to a numerous

class of compounds, formed by distilling a mixture of alcohol with the different acids.

What are some of the most important of this class of bodies?

Some of the most important bodies of this class are sulphuric ether, hydrochloric ether, hyponitrous ether, oxalic ether, and acetic ether.

How is sulphuric ether prepared?

Sulphuric ether is the most common, and is prepared by boiling equal weights of alcohol and sulphuric acid: it has been known for several centuries.

What are the properties of sulphuric ether?

Sulphuric ether is a coloress fluid: of a hot pungent taste, and fragrant odor; it combines with alcohol in all proportions, but not with water; it is highly inflammable, burning with a blue flame, and forming carbonic acid and water.

How is pure ether prepared?

Pure ether is prepared by mixing gradually equal parts of strong sulphuric acid and alcohol, and subjecting the mixture to slow distillation, into a receiver surrounded by ice, by a carefully regulated heat.

Of what is ether supposed to consist?

Ether is supposed to consist of two proportions of olefiant gas, and one proportion of water.

What are some of the properties of pure ether?

Pure ether is a colorless limpid liquid, of a hot pungent taste, and fragrant odor: it is highly inflammable, burning with a yellow flame; with oxygen gas its vapor forms a mixture which explodes violently on the approach of flame, or by the electric spark.

How is hydrochloric ether prepared?

Hydrochloric ether is prepared by distilling alcohol previously saturated with hydrochloric acid gas.

What are some of the properties of hydrochloric ether?

Hydrochloric ether is a colorless liquid, and burns with an emerald green flame without smoke.

By what name is hyponitrous ether frequently called?

Hyponitrous ether is often called nitric and nitrous ether, and is formed by distilling a mixture of strong nitric acid and alcohol.

What gives wines their peculiar odor?

Œnanthic ether gives to wines their peculiar odor, and is obtained in the distillation of wine. The ether is separated by distillation, and produces intoxication when inspired.

What are the properties of acetic ether?

Acetic ether is volatile, is heavier than most other ethers, and burns with a yellowish white flame, and during its combustion acetic acid is developed.

LECTURE LXV.

FERMENTATION.

When vegetable substances are exposed to warmth, what becomes of them?

Vegetable substances, when exposed to warmth, undergo spontaneous changes, and the process is called fermentation.

SACCHARINE FERMENTATION.

What substance is known to be subject to this kind of fermentation?

Starch only is subject to saccharine fermentation. The germination of seeds, and the ripening of fruits, have also been regarded by some chemists as examples of this kind of fermentation.

VINOUS FERMENTATION.

What substance only is capable of undergoing the vinous fermentation?

Sugar is the only substance, and the products of it are always alcohol and carbonic acid. The conditions necessary to this process are, the presence of sugar, water, yeast or some ferment, and a certain temperature. In the fermentation of bread, the saccharine matter of the flour is resolved into alcohol and carbonic acid gas; the latter causes the dough to rise, and the former is entirely expelled by the heat of baking.

What is yeast?

Yeast is a substance always generated during the vinous fermentation of vegetable juice and decoctions, rising to the surface in the form of a frothy, flocculent, somewhat viscid matter, the nature and composition of which are unknown.

How is beer manufactured?

Beer is manufactured by digesting malt, previously ground, with its weight of warm water, for several hours.

How is brandy procured?

Brandy is procured from the fermented juice of the grape, or wine.

How is rum procured?

Rum is procured from the fermented juice of the sugar cane.

Acetic fermentation is produced in what way?

When any liquid which has undergone the vinous fermentation, or even pure alcohol diluted with water, is mixed with yeast and exposed in a warm place in the open air, an intestine movement speedily commences, heat is developed, and the fluid becomes turbid from the deposition of a peculiar filamentous matter. Oxygen is absorbed from the atmosphere. These changes, after continuing for a certain time, cease spontaneously; the liquor becomes clear, and instead of alcohol, it is now found to contain acetic acid. This process is called the acetic fermentation.—T.

Putrefactive fermentation results in what?

The putrefaction of a substance, or its putrefactive fermentation, results in complete destruction.

Are all vegetable substances subject to putrefaction?

Many vegetable principles are not subject to putrefaction.

LECTURE LXVI.

CHEMICAL PHENOMENA OF VEGETATION.

What is germination?

Germination is the process by which a new plant originates from the seed.

Of what does a seed consist?

A seed consists essentially of two parts: the germ, which is endowed with the vital principle; and the cotyledon, or seed lobes, which furnish nourishment to the plant before it can derive it from the earth.

Of how many parts is the germ composed?

The germ is composed of two parts: the radicle, which shoots downward, is usually the first to break through the coats of the seed; and the plume, which rises into the air, and forms the stem of the plant.

How many conditions are necessary to germination?

There are three conditions necessary to the germination of a plant, viz. moisture, a certain temperature, and oxygen gas. Dry seeds will not germinate; or, if moist, germination will not take place at 32°, nor at the temperature of boiling water, which deprives the germ of its vitality.

Is air necessary to germination?

Air is essential to vegetation: under an exhausted receiver a seed will not germinate, although possessing every other requisite. If seeds are buried deeply in the earth, they will not vegetate, unless accidentally ploughed up or exposed to the contact of the atmosphere. Air furnishes that important agent, oxygen, which is the first moving principle of vitality.

GROWTH OF PLANTS.

Are there any points of resemblance between the growth of plants and animals?

There are many points of resemblance between the growth of plants and of animals.

What are the chemical changes called, which the sap undergoes?

The chemical change which the sap undergoes is called the respiration of plants, and is probably very analogous to what takes place in the blood of animals.

Where are the various chemical changes seen, that take place in the germination of seeds?

The chemical changes that take place in the germination of seeds, are seen in the process of malting. A kind of saccharine fermentation is produced, by which nutriment is supplied for the young plant during the early stages of its growth.

What constitutes the difference between the respiration of plants and animals?

Animals, during respiration, are constantly giving off carbonic acid; while plants, by the action of light, absorb carbonic acid, and give off oxygen.

FOOD OF PLANTS.

From what do plants derive their food?

Plants derive their food, for the most part, from the earth, the roots particularly: the leaves and stem receive nourishment from the air. There are some plants, however, which do not derive their nutrition from this source, as they are found to vegetate in distilled water, and to grow for some time when merely suspended in the air.

How is this accounted for?

On the supposition that carbonic acid is the proper food for plants.

Where is carbon obtained?

Carbon is obtained from the atmosphere, absorbed by the leaves of the plant, and appropriated to its nourishment.

How is the nitrogen of plants obtained?

The nitrogen of plants is probably obtained from the atmosphere, which always

contains a quantity of ammonia, derived from the putrefaction of organic matter. Some plants derive nitrogen from the atmosphere much faster than others.—Wheat, though it contains much nitrogen, is scarcely capable of absorbing it from the air, but derives it from the organic matter of the soil.

LECTURE LXVII.

ANIMAL CHEMISTRY.

What is said of animal substances?

Animal substances are less permanent than those of vegetable origin; and when life becomes extinct, they undergo a spontaneous change, and resolve themselves into new modes of combination.

Can animal substances be easily distinguished from vegetable?

Animal substances can not be easily distinguished from those of vegetable origin; but the former may be known by the peculiar and offensive odor given off by them during their combustion.

Of what does fibrin form the basis?

Fibrin forms the basis of the muscular or fleshy parts of animals; and is left, combined with albumen, when all the soluble *parts, consisting* of gelatine, osmazome, fat,

and various salts, have been washed away by hot water.

What are some of the properties of fibrin?

Fibrin is solid, white, insipid and inodorous. In a moist, warm situation, it readily putrefies; is insoluble in water at common temperatures, but is dissolved by the continued action of boiling water.

ALBUMEN.

Does albumen enter into the composition of animal fluid?

Albumen enters largely into the composition both of animal fluids and solids.

Where is liquid albumen found?

Liquid albumen is found in the serum of the blood, the liquor of serous cavities, the fluid of the dropsy, and the white of eggs.

From what is liquid albumen the best procured?

Liquid albumen is best procured from the white of eggs, which consists almost solely of this principle, united with water and free soda.

GELATIN.

Where is gelatin found?

Gelatin exists abundantly in many of the solid parts of the body, especially in the skin, cartilages, tendons, membranes and bones.

How is gelatin distinguished from all animal principles?

Gelatin is distinguished from all animal principles by its ready solubility in boiling water, and by the solution forming a bulky, semitransparent, tremulous jelly as it cools.

What are some of its properties?

Gelatin is insoluble in alcohol, but readily dissolved by most of the diluted acids.

By what name is the gelatine of commerce commonly known?

Gelatin is most commonly known by the name of glue.

How is glue prepared?

Glue is prepared by boiling in water the cuttings of parchment, or the skins, ears and hoofs of animals, and evaporating the solution.

How is isinglass prepared?

Isinglass is prepared from the sounds of fish, and it is the purest kind of gelatin.

From what is the animal jelly of the confectioners made?

The animal jelly of the confectioners is made from the feet of calves, the tendinous and ligamentous parts of which yield a large quantity of gelatin.

Of what do bones consist?

Bones consist of earthy salts and animal matter intimately blended; the former of which are designed for giving solidity and hardness, and the latter, for agglutinating the earthy particles.

What are the animal substances?

Animal substances are chiefly cartilage, gelatin, and a peculiarly fatty matter called marrow. On reducing bones to powder, and digesting them in water, the fat rises and swims upon its surface, while the gelatin is dissolved.

Of what are teeth composed?

Teeth are composed of the same materials as bone; but the enamel dissolves completely in dilute nitric acid, and therefore is free from cartilage. The composition of ivory is similar to that of the bony matter of teeth in general. The shells of eggs, and the covering of crustaceous animals, such as lobsters, crabs, and the star fish, consist of carbonate and a little phosphate of lime and animal matter.

Of what do the shells of oysters consist?

The shells of oysters, muscles, and other molluscous animals, consist almost entirely of carbonate of lime and animal matter; and the composition of pearl, and mother-of-pearl, is similar.

Of what does horn consist?

Horn consists of gelatin and a cartilaginous substance like coagulated albumen. The composition of the nails and hoofs of animals is similar to that of horn.

Of what are tendons composed?

Tendons appear to be composed almost entirely of gelatin: they are soluble in boiling water, and the solution yields an abundant jelly on cooling.

Of what are membranes and ligaments composed?

Membranes and ligaments are composed chiefly of gelatin; but they also contain some substance which is insoluble in water, and is similar to coagulated albumen.

Have animal oils any properties in common with the vegetable kingdom?

Animal oils have many properties in common with those derived from the vegetable kingdom, and are probably the same, but both have some peculiarities.

What are their ultimate elements?

Their ultimate elements are carbon, hydrogen and oxygen.

Train oil is obtained in what manner?

Train oil is obtained by means of heat, from the blubber of the whale; and is employed extensively in making oil gas, and for burning in common lamps.

What are some of the properties of train oil?

Train oil is of a reddish yellow color; emits a strong, unpleasant odor, and has a considerable degree of viscidity, which renders it unfit for being burned in Argand's lamps.

How is spermaceti oil obtained?

Spermaceti oil is obtained from the fatty matter contained in the bony cavity of the head of the whale. On subjecting this substance to pressure in bags, a quantity of pure *limpid* oil is expressed, called spermaceti oil.

What are some of the properties of spermaceti?

Spermaceti is an inflammable substance, of a white color and silvery lustre; it is brittle, soft and slightly unctuous to the touch, and insoluble in water. It has no taste, and scarcely any odor.

Hog's lard is of what color?

Hog's lard is a fat of nearly white color, and is used for domestic purposes.

What is suet?

Suet is a term applied to the fat situated about the loins and kidneys, which is less fusible than the fat from other parts of the same animal. The suet from beef and sheep is principally used.

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